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ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

The "St. Louis."

Every American is interested in the new steamship of the International Navigation Co., popularly known as the American line.

The new vessel stands for very much in the development of American industries, and will no doubt reflect credit upon her builders, the William Cramp & Sons Ship and Engine Building Co., of Philadelphia; not probably by reason of her speed, which is not designed to be phenomenal as steamship speeds go nowadays, but rather for her other qualities which go to make a comfortable, economical and generally satisfactory vessel.

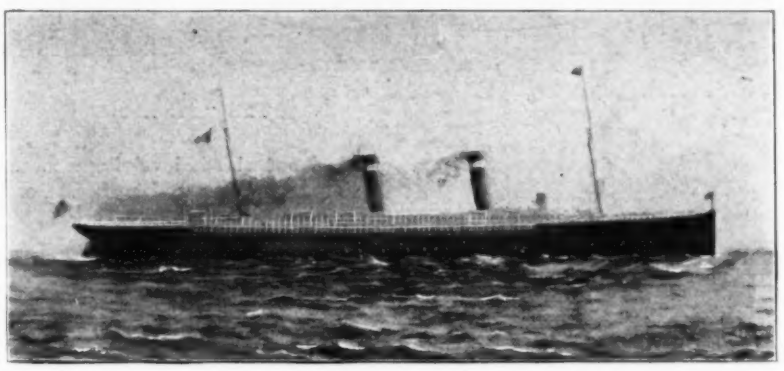
The first frames of the "St. Louis" were erected on July 23, 1893, and she was launched 15 months later. Her dimensions are: Length, 554 feet; length, between perpendiculars, 535 feet; extreme breadth, 63 feet; molded depth, 42 feet; number of decks, 5; number of water-tight compartments formed by transverse bulkheads and flats, 17; distance of collision bulkhead abaft of stem, 33 feet; displacement at 26 feet draft, 16,000 tons.

As will be seen from the above, the vessel was put in service in less than two years from the beginning of construction, and it is built entirely of American materials.

We give a view of one of the ten boilers, as seen lying in the yard. Six of these have double ends and four of them single ends. Steam is carried at 200 pounds pressure and the engines are quadruple expansion with six cylinders to each engine—two high pressures, 28½ inches diameter; first intermediate, 55 inches diameter; second intermediate, 77 inches diameter, and two low pressures, 77 inches diameter. They are arranged as indicated by the diagram, Fig. 1.

The cylinders are all jacketed and piston valves are used throughout. The frames are steel castings, and each upright is made in two parts bolted together at the center as indicated in the photographs because it was found impractical to get satisfactory castings of steel in one piece, as had been designed. The photographs were taken as the engines stood upon the erecting floor of the shop, and the two high-pressure cylinders are not in place because there was not sufficient head room to put them up. The supports for them are seen above the low-pressure cylinders.

The view of the engines is somewhat obstructed by scaffolding, but a general idea of their appearance can be obtained from



THE "ST. LOUIS."

engravings. Besides these there are 49 auxiliary engines used in working the ship, and 12 additional ones for lighting and ventilating; steam is used at a lower pressure in these, and its pressure is controlled by reducing valves, such as we illustrated in our issue of May 23d.

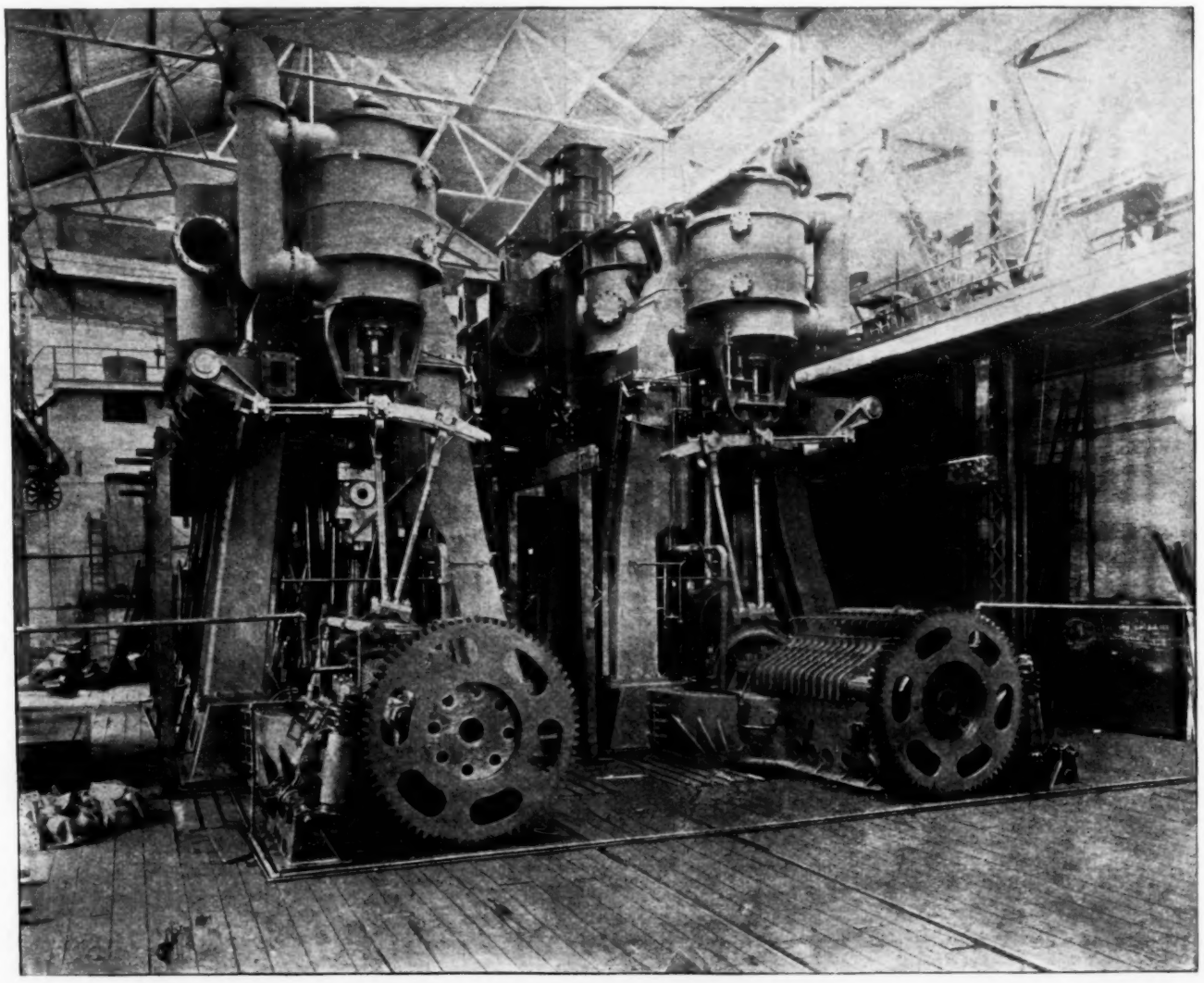
In the matter of safety extra care has been taken with the bulkhead system, the bulkheads being intact and without doors below the water line, excepting in a few places in the engine department, where special means are adopted for closing them, and where the engineers are always on watch. The vessel is so divided that in case of collision two, and even three, water-tight compartments could be flooded and not endanger the safety of the ship. The fastening edges of the bulkheads have been made unusually secure, so that if the ship sustained a shock in that place in collision the chances are that only one compartment would be flooded. This same arrangement has been made in the engine and boiler spaces. The boilers are in two groups, one group for each funnel. They are entirely separated from each other, and if one set of boilers became incapacitated the other set could do the work of supplying steam to the engines at a moderate rate of speed. The engines likewise are cut off from each other by water-tight compartments, and it would be possible to run the ship with either engine if the other should break down.

There are 1,300 electric lights in the ship, and four dynamos supply the current for them.

The passenger capacity of the ship is: First cabin, 350; second cabin, 200; steerage, 800. The crew will number about 400.

In finish and equipment the "St. Louis" is believed to be in advance of all other vessels, many improvements having been introduced for the comfort of passengers.

She is required to make a speed of 20 knots at trial; how much more than this she can make is, at this writing, undetermined, though it has been shown that her engines and other machinery work very satisfactorily.



THE "ST. LOUIS."

Mechanical Calculating Instruments.

BY WM. COX.

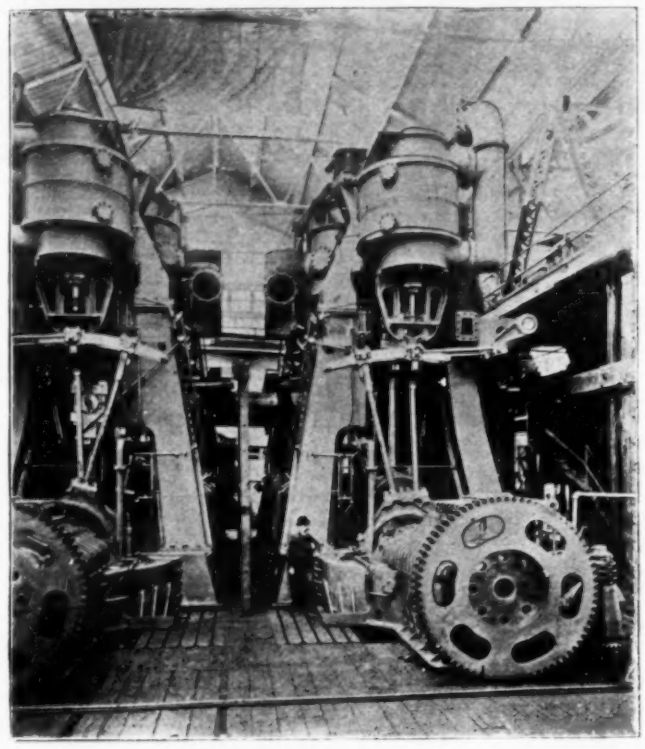
It is sometimes maintained that the use of mechanical means for working out more or less complicated calculations tends to weaken the mathematical faculties and perceptions. This is doubtless true in some cases, such, for instance, as when an expert accountant, accustomed to adding up quickly long columns of figures, resorts to one of the many mechanical devices invented for this purpose. He will certainly find that the continual use of this mechanical means to the exclusion of the former visual and mental method, will in a short time result in the almost complete destruction of the rapidity and ease with which he used to perform the work, although it may have the advantage of diminishing the mental strain.

If, however, a calculation consists of several different operations, such as multiplication, division, squaring, etc., the mathematical perceptions are kept fully alive by the necessity of studying what is the nature of each successive step which has to be taken in order to solve the problem. The use of a mechanical device for executing the actual work of calculating previously determined by mental effort, is

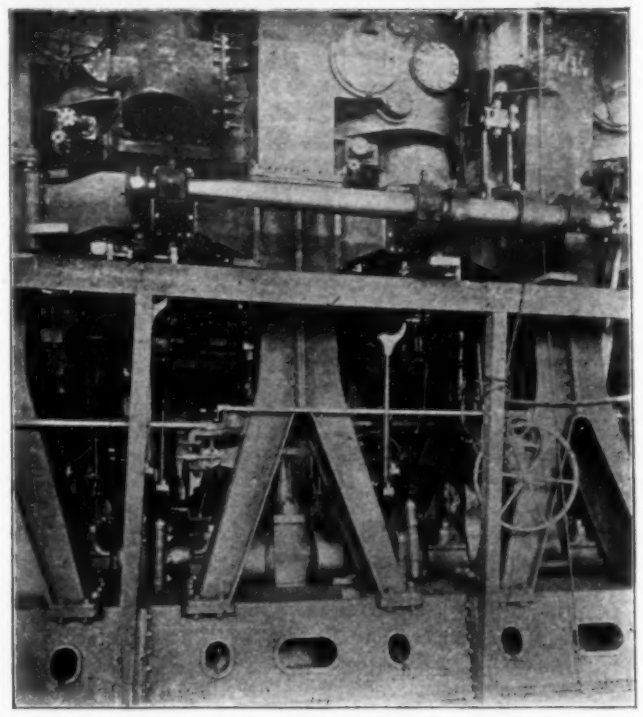
then found to be a relief, resulting also frequently in a diminution of the errors which will arise, notwithstanding the greatest vigilance, when the mathematical perceptions and faculties have to be alternately exercised.

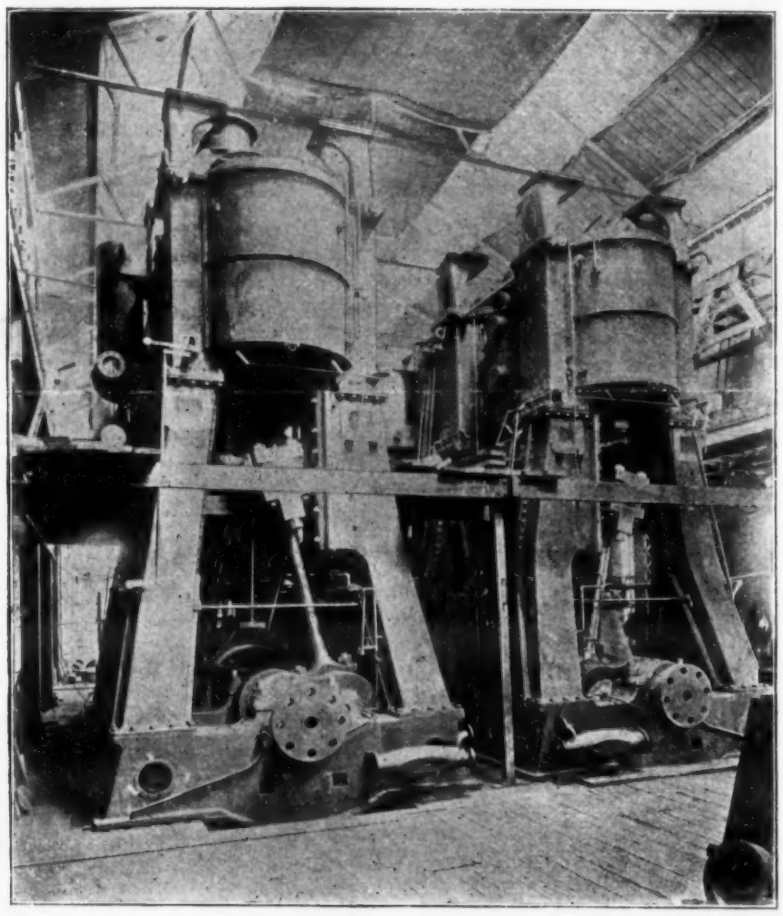
Much will therefore depend upon the nature of the work to be performed and upon the kind of instrument employed, as also naturally upon the competency of the individual to understand and solve, by the ordinary arithmetical methods, complex problems. When the necessary knowledge is wanting, the use of mechanical devices specially applicable to the solution of the problems under consideration becomes of inestimable value; and even when the ability is possessed, such devices are of the greatest use to check the calculations performed by the ordinary methods.

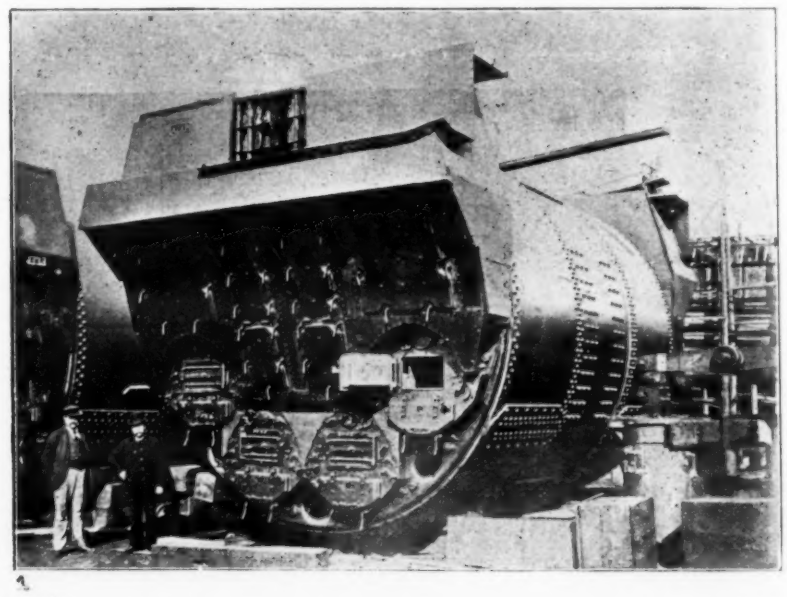
Mechanical calculating devices may be considered as belonging to two classes: those which in all their principles and motions are purely mechanical, and those which, while they embody some mechanical features, are dependent upon a combination of logarithmic or arithmetic scales. A notable example of the former is the arithmometer, first made applicable to practical use by Thomas de Colmar, in 1818, and subsequently improved and simplified by Mr. S. Tate and others. The best known and



THE "ST. LOUIS."







THE "ST. LOUIS."

most extensively employed of the various devices belonging to the second class is the common slide rule, invented by Edmund Gunter, in the early part of the seventeenth century.

The chief merit of the former class of instruments is found in the absolute exactitude of the results obtained, even in such cases as the product of ten figures multiplied by ten others, square roots, etc. Although a great saving of time may not always be effected, yet the saving of labor and mental wear and tear, coupled with the certainty of the results being correct, are of very great value.

The chief value of the instruments of the slide-rule class is found in the comparative rapidity of execution, with results correct to a certain degree, dependent upon the size of the instrument, that is, the length of the scales; just as a calculation worked out with four-place logarithms will be far from being as accurate as one worked out with a table of seven-place ones.

The following table, showing the results of a calculation of the area of a hexagon, of which the co-ordinates of the corners were given, will convey an idea of the relative amount of time required by different methods, as also the degree of exactness obtained by each:

Method Employed.	Area in Square Meters.	Time Occupied in Minutes.
Direct calculation	6663.61	9
Calculation with 5 figure logs	6663.57	9
Calculation with Fuller spiral rule	6663.6	7½
Calculation with 20-inch slide rule	6665.5	5
With the calculating machine	6663.61	10
With Zimmermann's multiplication tables.	6663.61	7½

It is here seen that the quickest method is the one with the slide rule, although the accuracy would in many cases not be sufficient, while the longest is that with the mechanical calculating instrument, giving a perfectly reliable solution with the least mental effort. With a slide rule having a much longer scale than the above, such as the Thacher, whose scale is 30 feet long, much more accurate results could be obtained; computations having been carefully worked out with it involving a mean error of not more than 0.0031 per cent., or about $\pm \frac{1}{32,000}$.

The distinguishing mathematical difference between the two classes of instruments is particularly seen in the case of the solution of problems in proportion. With the arithmometer and other instruments, such as the comptometer, belonging to the same class, the second and third terms of the proportion must be first multiplied together, after which their product is divided by the first term, giving the fourth term or result, the obtaining of which has thus necessitated two distinct operations.

With all instruments belonging to the slide-rule class, the first term is set opposite the second term, then without any further operation the fourth term or answer is read opposite the third term. This, of course, applies to all problems involving the expression $x = \frac{a \times b}{c}$, and largely accounts for the greater rapidity of execution obtained with this class of instruments.

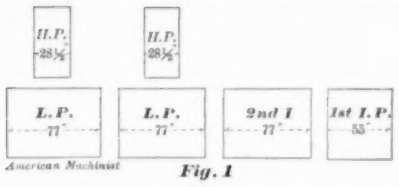


Fig. 1

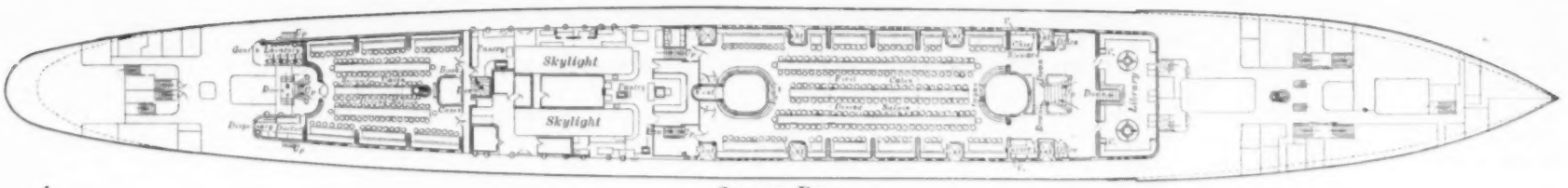
Reference has been made to mechanical devices specially designed for and applicable only to the solution of certain definite problems. All such belong to the slide-rule class, the results being obtained by a combination of 4, 5, 6 or more logarithmic scales, according to the number of factors in the formula to be solved. As an example, one of the most recent of these will solve the complicated formula:

$$D = \frac{C}{S_2} \sqrt{\frac{d^5 \times (p_1 - p_2) \times S_1}{l \times \left(1 + \frac{3.6}{d}\right)}}$$

giving in less than half a minute the volume and weight of steam that will flow through any pipe with any pressure, whereas the solution by the ordinary methods would require at least ten minutes, and necessitate the use of two if not three tables.

A further point in favor of these special devices is that the effect produced by the slightest modification of any one of the factors in the formula is immediately and thoroughly appreciated, whereas such can only be done at the cost of great labor when the arithmetical mode of solution is followed. By this means the mathematical perceptions are considerably stimulated, research into the cause and effects of changes becomes easy, while the routine labor is reduced to a minimum. This is the case with all problems solved by the slide-rule class of instruments, but it applies only in a very limited degree to the use of the purely mechanical instruments, whose chief value, as has been said, is to be found in the absolute accuracy obtained and the great relief from mental strain afforded when much work of a similar nature has to be done.

A good average is generally a creditable performance; but too tight at one end, and too slack at the other will not do for a machine fit.



SALOON DECK.

THE "ST. LOUIS."—UPPER DECK.

Various Causes of Boiler Explosions—I*

BY WILLIAM HENRY FOWLER, WH. SC., ASSOC. M. INST. C. E.

It is not universally understood that in boiler explosions it is not so much the steam as the hot water which is the destructive agent, so an inquiry as to where the energy is stored is an important preliminary to the study of the question. A boiler shell is normally in a state of high tension, and when once a rupture is produced by the action of the static pressures on a locally weak spot the stored-up energy is then capable not only of enlarging it into a complicated series of rents extending through the sound portions of the structure, but of producing all the other destructive effects. The amount of energy stored in the hot water and the steam of a boiler, and capable of being at once expended in the event of an explosion, is shown in Table I.

TABLE I.

Absolute Pressure.	Initial Temperature.	Total Energy Liberated on Reduction of the Pressure to Atmospheric Pressure, and of the Temperature to 212° F.	
		By 1 lb. of Water.	By 1 lb. of Steam.
Lbs. per Sq. Inch.	°F.	Foot-pounds.	Foot-pounds.
25	240	440	29,596
50	281	2,550	68,164
75	307	4,816	90,739
100	327	6,8·5	106,678
150	358	10,536	129 004
200	381	14,1·3	145,121
250	401	17,314	157,830

From this table it will be seen that the available energy stored in a body of hot water when the absolute pressure is 150 pounds, is enough to raise it to a hight of two miles, and at 250 pounds the available energy is enough to raise it more than three miles. A few actual cases are stated in Table II. and in it a comparison is drawn between the energy stored in boilers and the weight of gunpowder capable of an equivalent effect.

the right-hand side of the shell. The rupture occurred first at *A B*, where the plate had been externally corroded for about 8 feet of length until it was as thin as a sixpence and too weak for the ordinary working pressure. The extent of the corrosion is roughly indicated by the shading, Fig. 1, and the manner in which the secondary rents

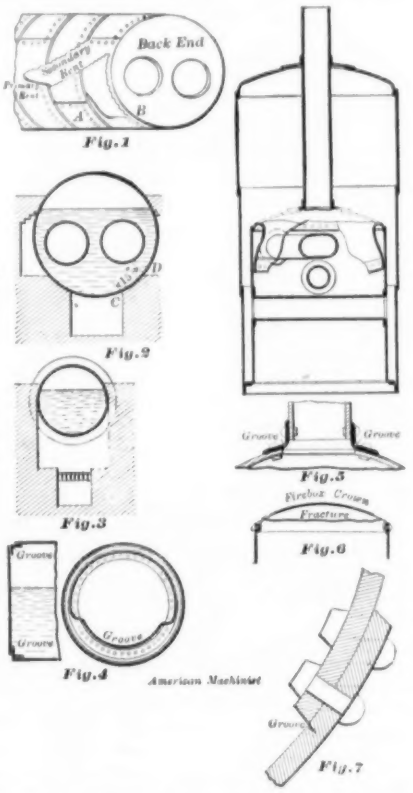


Fig. 1 Fig. 2 Fig. 3 Fig. 4 Fig. 5 Fig. 6 Fig. 7

were developed will be understood from the same figure. In this case the secondary rents did not extend far, and the evidence as to the relationship of cause and effect is clear, and it is not difficult to understand how the corrosion was caused. Fig. 2 shows that the brickwork seating, *C D*, upon which the boiler rested was 15 inches in width, and corrosion here could occur without being observed. Any moisture leaking into the side flue would drain to the point *D*, and

TABLE II.

Type of Boiler.	Dimensions of Boiler.	Working Pressure by Gauge.	Approximate Weight.			Available Energy.			Hight to which Energy would lift Boiler.	Gunpowder equivalent to Total Available Energy.
			Boiler.	Water.	Steam.	Water.	Steam.	Total.		
	Length. Feet. Dia. Feet.	Lbs. per sq. in.	Tons.	Tons.	Lbs.	Foot-tons.	Foot-tons.	Foot-tons.	Feet.	Lbs.
Lancashire..	27 × 7	100	12½	11½	46	93 000	2,351	95,351	7,628	795
"	30 × 8	150	21½	17	110	200,991	6,606	207,597	8,473	1,730
Egg-ended...	30 × 6	80	5½	10	88	64.740	4,083	68 823	12,513	574
Marine.....	15 × 13	150	39	24½	100	283,663	6,005	295,668	7,581	2,464

CAUSES OF BOILER EXPLOSIONS.

External Corrosion of the Shells.—Some of the most disastrous explosions have been from this cause. The corrosion is generally due to dampness of the brickwork, and this may be due to leaky rivets, pipes or cisterns, or to drainage when the boiler is below the level of the ground.

Case 1, Figs. 1 and 2, is an ordinary two-flue boiler which burst near the back end at

come in contact with the plates, and the width of the bearing made a secure lodgment for the water and made it difficult for the heat to drive it entirely away, even when the boiler was in use. It was found upon investigation after the explosion, that close to where the corrosion occurred there was a "jack-well," with a water level above the floor of the side flue, and the chain of causes leading to the explosion was complete. When the primary rupture is longitudinal, the secondary circumferential rents do not usually stop within such moderate limits as in this case. Sometimes corrosion has occurred at the bottom of the shell, where it rests on a mid-feather wall. This method of seating boilers has been fruitful of explosions, as affording a great opportunity for the accumulation of moisture.

Case 2, Fig. 3, shows a defective mode of setting that frequently causes corrosion. The result in the actual instance illustrated was that the leakage of a longitudinal seam kept the brickwork damp and set up the corrosion that led to the rupture.

External corrosion is comparatively slow in its action, at most about $\frac{1}{16}$ inch per year, and with a large factor of safety and searching periodical inspection it can be detected before it becomes serious. The flues should be large enough to allow the passage of a man with ease, and the concealment of large areas of plating by brickwork should be avoided. The jointing material between the boiler and setting should be of fire clay throughout, and not of common lime mortar, on account of its hygroscopic character. With the sizes of plates now produced, the longitudinal seams should be arranged to clear the brickwork.

Internal Corrosion of the Shell.—Next to the external corrosion is the internal wasting by the action of the feed water. The effects from this cause vary widely. Sometimes the plates are eaten over their entire surface and sometimes the corrosion is in pits, so that while the internal corrosion is often more rapid than external, the explosions from this cause are not so clearly defined. It is often a fact that the external and internal corrosions run in parallel lines.

Combined Corrosion and Mechanical Action: Grooving.—When corrosion is accompanied by bending movements, its wasting action is intensified, and "grooving" or channeling occurs. Fig. 4 is an example of the failures from this cause in cylindrical flat-ended boilers. The groove results from the breathing action in unstayed circular end plates with the changes of pressure. A local fretting action splits off the scale and oxide as fast as it is formed and exposes the plate for continual eating. The groove, of course, locates itself in the normally weakest spot or the place that bends the most. The mechanical movement has more to do with the formation of these grooves than the corrosion, for they form in the steam space almost as fast as under the water, and sometimes they eat clear through the plate before other parts of the boiler show any signs of wasting. Fig. 5 is a typical case of grooving in a vertical boiler at the junction of the uptake with the crown of the fire box. The uptake acts as a stay to the crown plate, and, in this case, when the stay became too weak for the pressure and let go, the fire box crown collapsed under the additional load and the boiler went up like a rocket. The attachment of the base of the fire box to the

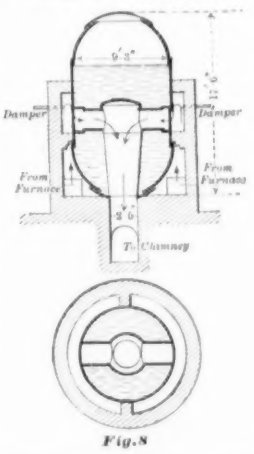


Fig. 8

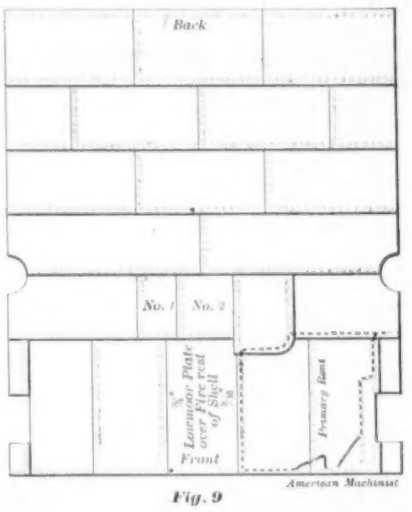


Fig. 9

shell was weak and yielding and probably promoted the grooving. Fig. 6 is a peculiar case of grooving in another boiler which exploded. The waste heat and gases went out through the side of the fire box, there was no uptake and the cumbered crown plate, on account of its excessive pliability, became

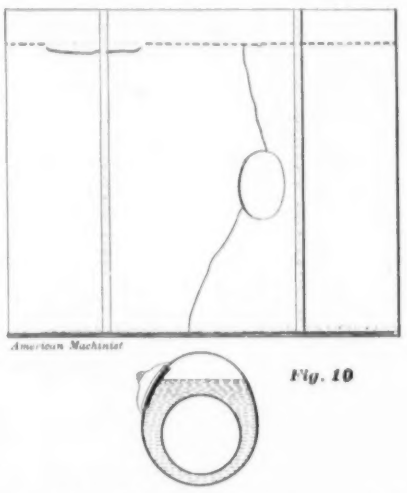


Fig. 10

grooved, as shown at the convex corner of the turned flange.

Grooving at Riveted Seams Between the Shell and Tubes.—This is sometimes found at the edges of the overlaps of both shells and furnace tubes. In the longitudinal seams, the bending action is because the shell is not truly circular, and the couple set up by the stress in the plates deflects the joint. The action is worse with boilers of small diameter and with a narrow single-riveted overlap. The injudicious use of calking tools sometimes starts the grooving.

Grooving in Locomotive Boilers.—The danger from grooving is much more serious with locomotive than with stationary boilers. A larger number of disastrous explosions have occurred from this cause than from all other causes put together. The grooving is at the longitudinal seams, and is so frequent because the barrels are of small diameter and the pressures fluctuate widely; the jolting also aggravates the case. The groove, as in Fig. 7, is sometimes so fine as to be almost invisible before the explosion. In explosions of locomotive boilers from longitudinal grooving,

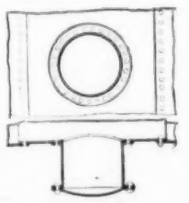


Fig. 11

* From "Proceedings of the Institution of Civil Engineers." Condensed by and for the AMERICAN MACHINIST.

it has always been with overlap joints and never with the double butt-strap type.

Stresses from Unequal Expansion and Contraction.—The severity of such stresses is evidenced by the explosion of long cylindrical boilers at circumferential seems, often with little warning. Boilers heated along the bottom tend to curl up at the ends, while cold feed water along the bottom causes opposing stresses. Fractures caused by this means sometimes run from the rivet holes to the edge of the overlap and sometimes from hole to hole, when they rapidly develop into "seam rips."

Rastrick Boilers.—Fig. 8 shows the general arrangement of this type of boiler, often used in iron works for utilizing the waste heat of puddling furnaces, and productive of some most disastrous explosions. The shell is practically of the plain egg ended type set upright, and the flames striking this first then pass through two or four cross tubes into a central descending flue tube. The heat from puddling furnaces is not great in quantity but is intense, and its impingement on the vertical plates of the shell, which are thick on account of its large diameter, causes overheating and distress at the riveted joints which suffer from lap fracture and sometimes seam rip. The sulphurous fumes of the furnaces are also destructive, the corrosion so caused being often not apparent and only to be detected by careful examination of the rivet heads and the edges of overlaps.

Fig. 9 exhibits an interesting case of failure of an externally fired boiler, the explosion in this case occurring two hours after the fires were drawn and with the pressure considerably below the maximum. The boiler was fired under the bottom, the waste gases passing through two internal flue tubes, the feed water left a sediment, and after three months use leakages at the ring seam over the bridge required patch No. 1, and shortly after patch No. 2 was added. This did not stop the leakage of the seams between the thick and the thin plates, one of which was torn as shown when the boiler was only two years old.

Insufficiently Strengthened Holes in Shells.—Many explosions occur from local weakness caused by manholes or dome holes without compensating rings or those that are inefficient for the purpose. This weakness has been clearly demonstrated in hydraulic experiments where in one case a Lancashire boiler gave way at the manhole under a pressure of 200 pounds, when the estimated bursting pressure for a seamless shell without the hole was 466 pounds. The mean circumferential stress did not exceed 8.6 tons, while the material had been proved capable of standing 20.6 tons. In another test with a small wrought-iron neck riveted around a 17-inch circular opening the boiler gave way at that point when the pressure had only reached 250 pounds. The sides of a dome will not add materially to the strength of a boiler shell which is locally weakened by a large hole, and even a small hole seriously weakens it. In an experiment with a cast-iron mouth-piece fitted around a 20-inch hole, although its sectional area was 30 square inches as against 8¾ square inches of the removed boiler shell plate, this part gave way at 200 pounds, proving that cast-iron is an unsuitable material for manhole mouth-pieces.

A New Double Cylinder Planing and Matching Machine.

This machine, of which we give an illustration, is made by J. A. Fay & Co., Cincinnati, Ohio. The machine is made in three sizes to plane two sides up to 24 inches, 28 inches and 30 inches wide, and 10 inches thick, and to match or joint up to 18 inches, 22 inches and 24 inches wide, respectively. The framing of the machine is massive. The journals, shafts, gears, screws, bolts, etc., are made to standard sizes, and under a system of interchangeable parts, so that duplicates can be readily supplied.

The cylinders are of solid forged steel and slotted on all four sides with journals $2\frac{7}{16}$ inches diameter, lead ground, with way bearings scraped to fit. The bearings of the upper cylinder are yoked together, and planed to fit cored uprights cast to a solid bed plate and bedded in a groove that keeps them in line. These bearings carry the pressure bar over the lower cylinder which rises and falls with them, but has also independent adjustment, and after the pressure bar is set for the cut of the lower cylinder it needs no other adjustment for variations of cut. The lower cylinder runs in a heavy frame, adjustable to suit the cut, and has pressure bars on each side of it.

The power-raising attachment is arranged so that the upper cylinder and feed rolls can be raised or lowered together, or so that they may be instantly thrown out of gear, and any desired adjustment made by hand. When the upright lever shown is thrown forward it unlocks the upper cylinder and tightens the belt operating the raising attachment, and another lever on the end girt, convenient to the operator, throws the friction in and out, and raises or lowers the cylinder and rolls as the lever is thrown one way or the other. A gage is placed on top of the side frame in a position to be easily read by the operator. Suitable stops are provided to prevent accidents from the cylinder and rolls traveling beyond a safe point. Ball bearings are placed under the upper cylinder screws rendering them easy of adjustment by hand when desired.

The matching arbors of steel $2\frac{5}{16}$ inches in diameter, and $1\frac{15}{16}$ inches where the heads are applied, have each three bearings, one of which is placed at the top of the spindle, which can readily be removed, for changing the heads, by removing one bolt.

A weighted matcher clip, with steel chip breaking lip, valuable for working cross-grained and knotty lumber, is hinged to the matcher hanger, and a uniform pressure maintained by means of the weight. Regular matcher heads of gun metal with steel screws and solid milled matcher cutters, or Shimer matcher heads, are furnished with the machine, as may be ordered.

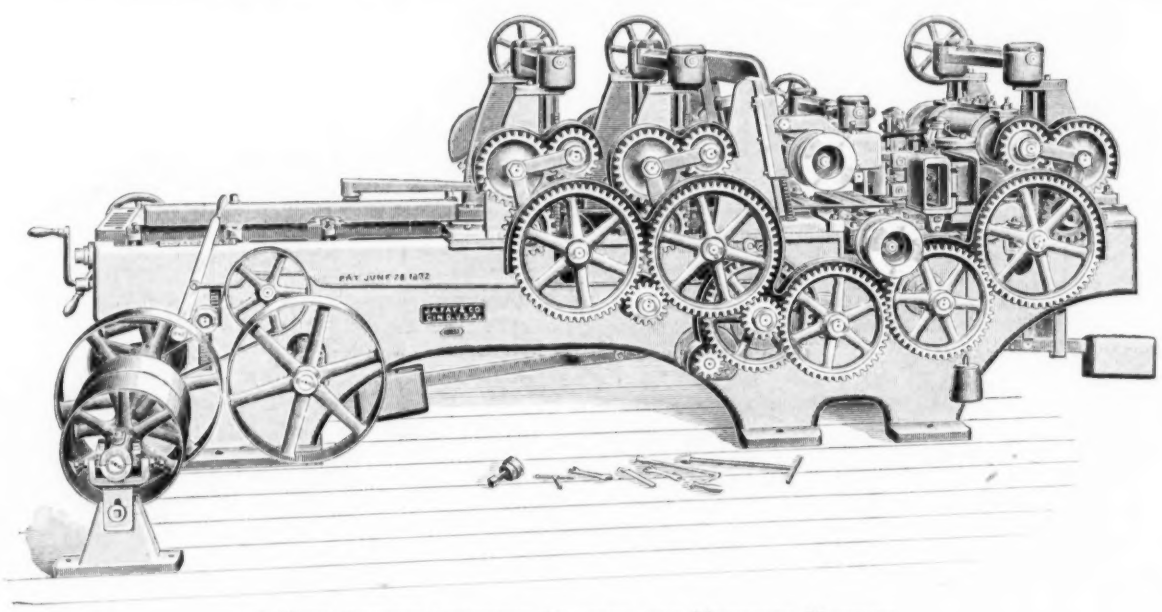
To prevent shavings produced by the side cutters from being scattered over the machine, to the annoyance of the operator, shaving hoods are fitted to each hanger, about the cutter heads, which direct all shavings away from the machine. These hoods are convenient in attaching exhaust pipes for the removal of the shavings by means of an exhaust fan. Pressure dogs are placed after the cut of the matcher heads to hold the material firmly while being matched. The matching works are placed after the lower cylinder, the material thus being brought to an even thickness before being operated on by the side cutters.

The feed works consist of six rolls 7 inches diameter, and with large journals, one pair, placed after the matcher works, keeping the board in a straight line, and feeding it entirely away from the machine. The feed rolls, mounted on planed upright stands, are fitted with socket joints and connected at each end by heavy expansion gearing with double or outside links, and are heavily weighted. The weighted levers are inside the machine, and move with perfect freedom. The feed of the machine is very powerful, the rolls being large, and the belting, gearing and weighting being so proportioned as to allow no slipping. The front platen has two rollers in it to relieve heavy timbers of friction, and this platen is arranged to admit of using the regular arm for holding the material against the guide, or a wooden lever as preferred.

Ordinarily two rates of feed are furnished with the machine, 41 and 56 feet per minute, respectively, but other speeds are provided if desired.

Each machine weighs 15,000 pounds, and has a shop number attached to it, and there is also a number on each casting.

The countershaft has tight and loose pulleys, 16 by 10 inches, and should make 1,000 revolutions per minute.



A NEW DOUBLE CYLINDER PLANING AND MATCHING MACHINE.

Plates of Uniform Strength.

BY ALBERT E. GUY.

SECTION 12.

RIBBED PLATES—CONTINUED.

The preceding paragraphs treat of cases occurring frequently in practice, and will be found useful for determining the dimensions and strength of cylinder flanges and covers composed of plain or flat circular plates. More frequently still engineers and draftsmen have to deal with ribbed plates, but no formulæ are to be found in any hand or text-book to help the designer in his work. There is, however, a good collection of experimental data and records of a great number of constructions and machines which have successfully stood the test of time. Nevertheless the lack is felt of a sound theory which would put a little order in this mass of documents and data and would generalize the subject in such a way that new cases could be treated by logical deductions from the rules established.

In treating the flat rings and plates in the preceding chapters,* endeavoring to handle the subject with the least possible mathematics, it has been necessary to neglect, for the time being, certain forces which play an important role when very elastic or thin material is used for the plates (wrought-iron or steel as in boiler work), but which are nearly insignificant when brittle material is dealt with (cast-iron and brass). These forces may be totally neglected in the case of ribbed plates when the ribs and web are cast together. Then all the general considerations employed in the first part of this work become good for the present one, and we may use here the general formulæ we have established. They are all of the form:

$$M = \frac{I}{a} \cdot f.$$

* See AMERICAN MACHINIST, issues of July 5th, October 4th, October 18th, November 15th and 29th, December 20, 1894.

M = bending moment;
I = moment of inertia of the section of the beam or plate considered;
a = distance from the neutral axis to the most strained fibers;
f = the permissible strain of the material.

The work has been relatively easy for us since we have had to deal only with plates rectangular in section, for which $\frac{I}{a} = \frac{b\,h^2}{6}$; the symbol b is the length of the section, and for any radius of a circular plate, $b = 2\,\pi\,r$. The object of the calculations being to find the hight or thickness h of the section at any radial length r from the center of the plate, hence b is a known quantity and h is easily determined.

With radially ribbed plates the conditions change, for we have to deal with T, Γ or E sections, and circumstances seem to have multiplied the difficulties of the problem, since for a T or Γ section the modulus $\frac{I}{a}$ has no less a value than:

$$\frac{I}{a} = b\,h^2 - b_1\,h_1^2 - \frac{4\,b\,h\,b_1\,h_1\,(h-h_1)^2}{b\,h^2 - b_1\,h_1^2}$$

For a E or I section,

$$\frac{I}{a} = \frac{b\,h^3 - b_1\,h_1^3}{h}.$$

A cast-iron cylinder bottom of radius $R = 20''$, supports a uniform pressure $p = 100$ pounds per square inch. It is required to calculate its dimensions, considering it as firmly fixed at the edge or cast with the cylinder.

In paragraph 2, equation (17) expresses the thickness of a plate firmly fixed at the edge and uniformly loaded. If this thickness is not too great, we may dispense with

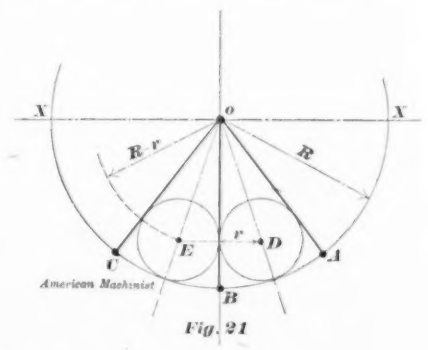


Fig. 21

ribs for the bottom. The thickness of the cylinder wall is:

$$t = \frac{p\,R}{f},$$

f is the allowable stress per square inch of the material; for convenience let us make it = 3,000 pounds; then

$$t = \frac{100 \times 20}{3{,}000} = 0''.66.$$

The thickness of the bottom plate should not be very much in excess of that of the wall.

Equation (17) is :

$$h_{max.} = 0.938\ R\sqrt{\frac{p}{f}};$$

hence :

$$h_{max.} = 0.938 \times 20\sqrt{\frac{100}{3{,}000}} = 3''.425.$$

This value is too great, and although h at center equals zero, *theoretically*, it would be absurd to design a cylinder bottom of 3 ".425 maximum thickness, while that of the wall is only $\frac{3}{4}$". Let us then make the bottom with a thinner plate strengthened by ribs. The first question to deal with is: *What should be the number of the ribs?*

Apart from the empirical rules given in hand-books, we may use the following formula, by anticipation, as we have only treated the circular plates up to the present time, and since it is derived from one expressing the strength of a triangular plate having for sides two straight lines and an arc of circle, the number of ribs is :

$$(113_a) \qquad n = 2\,\frac{R}{h}\sqrt{\frac{p}{f}}.$$

Making $h = \frac{3}{4}'' =$ thickness of web, we have :

$$n = \frac{2 \times 20''}{(\frac{3}{4})''} \cdot \sqrt{\frac{100}{3{,}000}} = 11.685;$$

in round number $n = 12$ ribs.

The following method may also be employed with sufficient accuracy. Fig. (21) represents part of the plan of a ribbed circular plate. The metal inclosed between any two ribs $o\,A$ and $o\,B$ and the arc $A\,B$ must be strong enough to withstand the pressure $p = 100$ pounds per square inch, It will suffice in most cases to calculate the strength of a circular plate, of radius r. circumscribed within these three lines. Using Grashof's formula for a plate of uniform thickness, the value of r for a given thickness h is,

$$(113) \qquad r = h\sqrt{\frac{3}{2} \cdot \frac{f}{p}}.$$

The distance $D\,E = 2\,r$ assume to be one of the n sides of a regular polygon inscribed within a circle of radius $O\,E = R - r$.

(114) The side $D\,E = 2\,(R - r)\sin.\left(\frac{180}{n}\right)$;

hence,

$$(115) \qquad r = \frac{R \sin.\left(\frac{180}{n}\right)}{1 + \sin.\left(\frac{180}{n}\right)}.$$

Since thickness $h = \frac{3}{4}''$, equation (113) gives us,

$$r = \tfrac{3}{4}\sqrt{\frac{3}{2} \cdot \frac{3{,}000}{100}} = 4\,'.187;$$

and by equation (114),

$$\frac{r}{r - r} = \sin.\ \frac{180}{n};$$

whence $\sin.\left(\frac{180}{n}\right) = \frac{4.187}{20 - 4.187} = 0.26483.$

We find in the table of sines that 0.26483 is the sine of an angle of $15.^{35}_{100}$ degrees, hence the number of ribs

$$n = \frac{180}{15.35} = 11.726;$$

in round number $n = 12$ ribs.

It will be found convenient to make the ribs of the same thickness as the web, *i. e.*, $\frac{3}{4}$".

Detroit Meeting of the American Society of Mechanical Engineers.

The spring meeting of the American Society of Mechanical Engineers was held in the city of Detroit last week, according to the program previously announced, and adds another to the long line of professionally and socially successful meetings to be credited to the society and its hosts.

The New York contingent did not travel to the rendezvous by the originally planned route, because at the last moment, when everything seemed to be satisfactorily arranged for transportation, the Grand Trunk passenger department refused to run a dining car on the train, the result being that another road got the business. Mechanical engineers do not travel quite as much as some other classes of people, perhaps, but when they do, they must of course have all the latest and best improvements.

The trip was made without special incident except that a combination of grade and curve encountered just after leaving Albany stalled the train for about half an hour, until a third engine could be brought into service as a pusher, the New York Central road having evidently not yet had sufficient experience to enable them to decide just how much of a passenger train can be pulled and pushed over that piece of track by two engines.

The train was finally pushed onto the large transfer boat at the Detroit River on time, however, and this curious boat with its two duplex, horizontal engines, below decks, driving the separate paddle wheel shafts through the medium of large spur gears and pinions, carried the party again to the United States, where, upon coming from the station, most of the male members of the party might have been seen furtively sequestrating omnibus tickets purchased on the train in blissful ignorance of the fact that carriages specially provided by the reception committee were in waiting for them.

The first thing on the program of the entertainment committee was a steamboat ride to Belle Isle Park, which is a beautiful park of 700 acres laid out upon an island belonging to the city of Detroit. A long line of carriages took the party from the boat landing around the island and back to the city, by way of the fine bridge which forms the second means of communication between the city and its park. It was very hot weather, but the ride was an enjoyable one nevertheless.

TUESDAY EVENING'S SESSION.

The first session of the society developed the fact that the hall chosen for its sessions was not an ideal place for such meetings. It is in the second story of the fine Y. M. C. A. building—so near the street as to make the street noises often more audible than the voices of those who were reading or discussing papers. Besides, the acoustic properties of the hall seemed not to be of the best, though this could be better judged, perhaps, were it not for the fact that the heavy rails and switches of one of Tom Johnson's newest trolley roads were being laid by the aid of much hammering just outside the windows, which had to be kept open for some relief from the heat.

There was no address of welcome nor presidential address ; the society proceeding immediately to business at the appointed hour, by the presentation of the first paper, which was entitled "The Old and the New." This was written by Robert Allison, of Port Carbon, who would have presented it in person, had it not been for the fact that the citizens of Detroit seem still to think that the regular daily round of duties, such as rising, eating breakfast, going to work, and so on throughout the day can be properly performed only when the hands of watches and clocks are in certain positions. Detroit goes by what is usually called "sun time," which in Detroit is about half an hour faster than standard time. The meetings were opened by sun time. However, Mr. Allison got in in time to take part in the discussion of his paper, which was published in full last week, together with that part of the discussion upon it which had been prepared in advance of the meeting.

In the further discussion, Mr. Geo. I. Rockwood, of Worcester, speaking of what had been said by Olin Scott about water wheels, said it was a surprise to note the manner in which water wheels were designed. He doubted if any maker of turbine water wheels could give a satisfactory reason why his wheel would give, say, 80 per cent. efficiency. The usual method of procedure seemed to be to build a wheel, and then take it to Holyoke and test it and experiment with it until it gave a satisfactory efficiency ; then this wheel was taken as the pattern or model for succeeding ones, without much attempt to examine into the science of the construction, or to know much of the principles involved.

He said that at the Worcester Polytechnic Institute, ho ever, they had recently put up a very com, lete plant for testing water wheels, arrangements being made for accurately measuring the water used, by means of the Venturi meter, which was used at the Columbian Exposition, and also by an accurately constructed weir. There were also means for measuring the power developed.

The paper was also discussed by Messrs. Holloway, Washington, Jones, and others, the former paying a tribute to the skill of the old-time machinists, whose work was done absolutely without the tools that are at command now. Their work was handicraft ; the present work consists in good machine tools, well managed. He said the first high-speed engines were built by Eaton Rogers, of Dayton, Ohio, many years ago. They were about 8' x12', and made 300 revolutions per minute. These were the engines of muley saw-mills.

Mr. Jones related his experience when an apprentice at the Southwark Foundry in Philadelphia, where, when the bed-plate of the engine for the U. S. naval vessel "Mississippi" was to be cast, he was sent around with invitations to the citizens of Philadelphia to come and see the casting poured. It weighed five or six tons. This bed was finished entirely by chipping and filing.

The next paper was entitled "Description of a New Form of Sterilizer." By A. M. Goodale, Boston, Mass.

This apparatus was designed for sterilizing materials used in a large hospital. The operation of sterilizing consists of heating to a temperature sufficient to destroy the bacilli. A cylindrical shell contains a rectangular chamber for holding the material upon trays, with coils of small steam pipe surrounding the four sides. Steam is admitted to the whole chamber, and to the coils independently. The live steam at 25 or 30 pounds, and 260 degrees, effects the sterilization by direct contact, and after that steam is discharged the steam in the coils dries everything so rapidly that as soon as the steam is all discharged from the chamber the articles may be removed.

There was no discussion.

The next paper was entitled "A Portable Disinfecting Plant." By W. H. Francis, Philadelphia.

This is a different and more elaborate form of apparatus for the same purpose as the preceding. The clothing is hung upon the rack, and run into the steam chamber, and heated by the jacket steam. A vacuum pump is then started, and removes the air, after which the steam is admitted to the chamber striking a hood, the condensation flowing down the sides of the chamber instead of upon the goods. After a sufficient exposure the steam is discharged, and the rack is withdrawn.

A second apparatus described is a fumigator. The sulphur furnace is double, and the sulphur is held in a cast-iron pan under slow combustion. Additional sulphur can be supplied without opening. The fumes travel through the furnace, and are then sucked by an exhaust fan into the building to be fumigated.

There was no discussion.

As little time was taken by the presentation of these papers, the long-neglected "Topical Questions" were taken up, and No. 122 was discussed. This is, "Can it be made practicable to design a machine which shall unite the merits of both the milling machine and the planer? Is not this problem a paradox in machine construction ?"

Henry B. Binsse, of Newark, N. J., presented the first discussion, claiming that the milling machine was not adapted to jobbing work, that cutters were too costly and too easily spoiled by hard castings—castings that would not much affect the planer, and, in fact, could be readily finished by it, only not quite so rapidly as usual perhaps. Regarding the claim sometimes made that the milling machine was not thoroughly understood, he thought this was not so, that it was as well understood as any other machine tool here, where all the best types of the machine have originated.

W. S. Rogers thought cutters were not expensive when the work done by them was considered, and he thought the time would come when milling machines would be used quite generally for jobbing. One of the first things he would put into a jobbing machine shop would be a suitable milling machine.

Question No. 123 was then presented. It reads, "For filtering oil having very finely divided metallic particles in suspension, what have you found to be the best filtering material, either for one operation or in series?" One unidentified member sent in a written discussion in which he said he had used with success two pans, one placed above the other, and had carried oil over the sides of the upper one and into the lower one by means of wicks.

At the close of the meeting an informal reception was held in an adjoining lecture room, the most notable feature of which was perhaps the very well prepared and well-conducted refreshment service, presided over by Miss Willcox, who is at the head of the Women's Exchange.

WEDNESDAY MORNING'S SESSION.

The first thing at this session was the presentation of committee reports, and of two monographs by W. J. Keep, of Detroit, in which he treated the subjects of "Transverse Strength of Cast-Iron and Keep's Cooling Curves;" "A Study of Molecular Changes in Metals Due to Varying Temperatures." No adequate presentation of these papers, or of the discussion upon them can be given within the at present available space, and they will be considered later.

The committee appointed to investigate the question of a uniform standard gage for sheet metals, reported in favor of a gage of oval form (to distinguish it), and having notches with numbers corresponding to the size of the notches expressed in thousandths of an inch. The secretary reported that other societies who had been asked to take action in the matter had endorsed the proposed gage, and by vote of the society the report of the committee was "accepted and placed on file," which, in some way, is thought to be very different from "adopting" a report, or "recommending" it.

ST. LOUIS THE PLACE OF THE NEXT SPRING MEETING.

Col. E. D. Meir, on behalf of the St. Louis Manufacturers' Association, and of the Business Men's League, extended an invitation to make St. Louis the place of the meeting in the spring of 1896, and it was voted as the sense of the meeting that this invitation be accepted, and the council directed to make the necessary arrangements.

At the close of the meeting the members walked a short distance to the Board of Trade building, where a lunch was served under a canopy upon its high roof.

WEDNESDAY AFTERNOON'S SESSION.

Most of the papers listed for the previous session had to be postponed to this one, and the first taken up was "The Strength of Iron as Affected by Tensile Stress When Hot." By De Volson Wood, Hoboken, N. J.

This is a record of some experiments in which specimens of good iron were heated to a dull red, and subjected to a pull while hot. The results indicated a slight diminution of strength by stretching when hot, but if the stress does not exceed one-quarter of the ultimate strength, the loss is only about 1½ per cent., and unless there is a perceptible elongation while hot, the specimen is not weakened. A table of the tests in detail accompanies the paper.

Gus. C. Henning, in discussing the paper, called attention to the fact that the reduction of strength in the pieces corresponded almost exactly with the reduction of area by the stretching while hot, and claimed that the paper showed nothing more than that small bars of iron were weaker than larger bars of the same iron.

Professor Wood was not present.

(*Continued on page* 529.)

Statistics of the Railways of the United States.

An abstract of the report of the Interstate Commerce Commission for the year ending June 30, 1894, has just been given out, and contains many facts of interest that we suppose could not well have been compiled at an earlier date. The conditions existing during the period covered by the report cannot be considered normal. The last four months of the time of, and a much larger proportion of the traffic in connection with the Columbian Exposition are included, and a widespread and unprecedented business depression covered the whole period. The figures tell of arrearages in maintenance and equipment that we may hope to have to make up in the near future.

There were 1,924 corporations, an increase of 22; and 192 roads, with 42,000 miles of line, and one-fourth of the total capitalization, were in the hands of receivers. The total mileage was 178,708 miles of road, and 233,533 miles of track. The increase of roadway was 2,247 miles, against 4,897 miles increase for the year before. By merging and consolidation 90 roads operate 72.9 per cent. of the total mileage.

There were 35,492 locomotives, an increase of 704. Of these 9,893 were passenger, and 20,000 freight, with 5,086 for switching, and some unclassified. The cars were 1,278,078, of which 33,000 were passenger, and 1,205,000 freight, with about 40,000 caboose, derrick, gravel, officers, pay, etc. The increase was 4,132, against 58,854 for the year before, but a great many old and worn out cars were destroyed.

The number of passengers carried was 619,688,199, an increase of 26,127,587, but the increase was in World's Fair travel. The passenger mileage was 14,289,445,893. The average of passenger to a train was 44, and the average trip was 23 miles. There were 62,639 passengers per passenger locomotive, and 1,444,400 passenger miles. There were 53 cars for each 1,000,000 of passengers.

The freight carried was 638,186,553 tons, a decrease of over 16 per cent. The ton mileage was 80,335,104,702. There were 180 tons of freight to a train, and the average haul was 126 miles. There were 31,909 tons per freight locomotive, and the ton miles per locomotive were 4,016,755. 1,888 freight cars were required for each 1,000,000 tons.

There were 779,608 railway employes, a decrease of 10.76 per cent. The decrease in trackmen was 16.34 per cent., and in laborers and unclassified help 18.91 per cent. In help for maintenance of way and structures, the decrease was 15.94 per cent., and in maintenance of equipment, 13.38 per cent.

The average daily compensation for three years was: General officers, $9.71; other officers, $5.75; general office clerks, $2.34; station agents, $1.75; enginemen, $3.61; firemen, $2.03; conductors, $3.04; trainmen, $1,89; machinists, $2.21; carpenters, $2.02; section foremen, $1.71; trackmen, $1.18; switchmen, flagmen, and watchmen, $1.75; telegraph operators and dispatchers, $1.93.

The total amount of railway capital was $10,796,473,813, or $62,951 per mile. The capital stock was $4,834,075,659. 63.43 per cent. of the stock was paying no dividend. The total amount of dividends was $95,575,976, or an average of 5.41 per cent. for the dividend paying stock.

There were 1,823 employes killed, and 23,422 injured, compared with 2,727 killed, and 31,729 injured in the year before. 251 were killed in coupling cars, 439 in falling from trains and engines, 50 by overhead obstructions, 145 by collisions, 108 by derailments, and the balance by various causes. 1 employe was killed out of 428, and 1 in 38 was injured. Of trainmen, 1 in 156 was killed, and 1 in 12 was injured.

There were 324 passengers killed, an increase of 25, and 3,304 injured, a decrease of 195. 1 passenger was killed for 1,612,618 carried, or for 44,103,228 miles traveled, and 1 injured for 204,248 carried, or for 4,709,771 miles traveled.

Centrifugal Force.

BY J. BEGTRUP.

It is my object here to give an analysis of centrifugal force, which shall be exact, complete and truly elementary. The demonstration must necessarily be mathematical, but the mathematics will be of the most primitive sort.

In Fig. 1, a heavy particle at m is supposed to move with uniform velocity in a circle, being tied to the center o by a string. If the string should break, the particle would continue its motion in a straight line tangential to the circle, for the straight line is the natural direction of motion, but the particle is *forced* by the string to move in a circle. The pull from the string on the particle is called the deviating force, and the reaction of the particle on the string is called centrifugal force; these two forces are therefore equal and apposite. While the particle moves from m to n, it is forced to move a distance $k\ n$ at right angles to its natural direction of motion; for if the string had broken at m, the particle would have been somewhere on the line $m\ l$ instead of at n; but this fact cannot be used as a basis for the calculation of centrifugal force, for this force is radial, that is, at right angles to the *actual* motion.

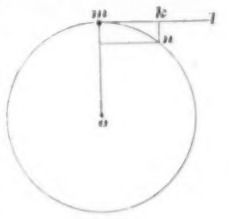


Fig. 1

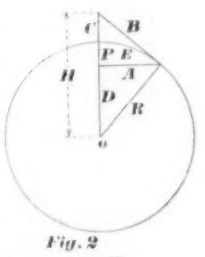


Fig. 2

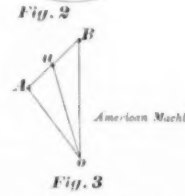


Fig. 3

But suppose we make $m\ n$ very small, then $k\ n$ will be nearly radial, and if we make $k\ n$ infinitely small, $k\ n$ becomes exactly radial, and if we then can find the deviating force acting in this radial direction, we have found the centrifugal force. We first want to find a relation between $k\ n$ and $m\ n$ when these two distances become infinitely small, and this being found, we shall know how much the particle would be moved in a perpendicular direction by the deviating force in unit of time, and then the deviating force or centrifugal force can easily be found.

In Fig. 2, we have A perpendicular to D and B perpendicular to R, E being the arc through which the particle is supposed to have moved. I shall first show that $C = P$ when the arc E becomes infinitely small. By similar triangles $H : R :: R : D$ or $H - R : R - D :: R : D$ or $C : P :: R : D$; but for an infinitely small arc $R = D$, and consequently in that case $C = P$. Again, by similar triangles $A : R :: C + P : B$ or for an infinitely small arc $\boldsymbol{A} : R :: 2\ P : B$, hence

$$A\ .\ B = 2\ R\ .\ P.$$

I shall now show that for a very small arc $A\ .\ B = E^2$. By dividing E into equal elements and drawing lines parallel to P, A will be divided in the same number of elements, each of which is smaller than the corresponding element of E, and the difference will continually decrease as the arc becomes smaller, and will finally disappear when two corresponding elements become parallel, that is, for a very small arc $A = E$. By a similar argument we get $B = E$ when E becomes very small, and therefore for an infinitely small arc $E = \boldsymbol{A} = B$, or $E^2 = A\ .\ B$, that is,

$$E^2 = 2\ R\ .\ P.$$

If, now, the particle moves with a uniform velocity v, the time of motion through arc $E = \frac{E}{v}$, or time $= t = \frac{E}{v}$, or $t^2 = \frac{E^2}{v^2} = \frac{2\ R\ .\ P}{v^2}$, hence

$$P = \frac{t^2\ v^2}{2\ R}.$$

P represents here the deviation from a straight line in a very short time t, and the question becomes now: What is the magnitude of the force which will move the particle a distance $P = \frac{t^2\ v^2}{2\ R}$ in the time t?

Let acceleration per unit of time due to the deviating force $= k$, then the mean velocity in the direction of this force in the period $t = \frac{k\ t}{2}$, and the displacement $= \frac{k\ t^2}{2} = P = \frac{t^2\ v^2}{2\ R}$, hence by elimination of $\frac{t^2}{2}$

$$k = \frac{v^2}{R}.$$

Let the mass of the particle $= m$, then deviating force = centrifugal force $= m\ .\ k = \frac{m\ v^2}{R}$, or putting $m = \frac{w}{32.2}$, where w is the weight of the particle, we get:

$$\text{Centrifugal force} = \frac{w\ v^2}{32.2\ R} \text{ pounds.}$$

It should be remembered that in this formula $w =$ weight in pounds, $v =$ velocity in feet per second and $R =$ radius in feet. For the calculation of ordinary machinery, it is convenient to use an inch as unit of length and to express the velocity by revolutions per minute, then centrifugal force $= .0000284\ N^2\ w$ for each inch of radius, where $N =$ revolutions per minute; this gives for $N = 100$, 200 and 300 centrifugal force for each inch of radius $= .284\ w$, $1.138\ w$ and $2.560\ w$ respectively.

I shall now show that the centrifugal force of a body which is symmetrical in relation to a plane perpendicular to the axis of rotation is the same in magnitude and direction as if the whole mass of the body was concentrated at the center of gravity. We may consider a material body as made up of a great number of "heavy" or material particles. In Fig. 3, let o be the center or axis of rotation, and let A and B be two material particles of the body which is supposed to rotate about o. Also suppose all the particles to lie in one plane perpendicular to the axis of rotation, and let T be the number of revolutions the body makes in a second, then if m represents the mass of each particle, centrifugal force of such particle $= 4\ \pi^2\ m\ T^2\ R$, which may be written centrifugal force $= c\ R$, c being a constant factor for all the particles. It is, therefore, evident that the centrifugal force of each particle being proportional to its radius may be graphically represented by this radius. Thus we have $o\ A$ and $o\ B$ representing the centrifugal forces of particles A and B respectively. Now make $U\ A = U\ B$ and resolve $o\ A$ in two forces $o\ U$ and $U\ A$, and $o\ B$ in $o\ U$ and $U\ B$, we have then two forces $U\ A$ and $U\ B$, which being equal and apposite are in equilibrium, and a resultant centrifugal force $= 2\ o\ U$, and this single force can therefore be substituted for the two forces $o\ A$ and $o\ B$, but U is the common center of gravity for the two particles A and B, and if we had collected these two particles at U, the centrifugal force would also be represented by $2\ o\ U$; thus we see that the resultant centrifugal force is equal in direction and magnitude to the centrifugal force of the two particles collected at their common center of gravity. The centrifugal force of every pair of particles in the body may now be reduced to single forces in the same manner, and every pair of these resultant forces may again be reduced, and so on, till the centrifugal forces of the whole body have been reduced to a single force acting at a single point, and this point is the center of gravity of the body where the whole mass is supposed to be concentrated.

If the form of the body is such that it can be divided symmetrically by a plane at right angles to the axis of rotation, then every two symmetrically located particles may be reduced to a single particle in the symmetry plane and the resultant centrifugal force can be found as above. But if the body cannot be divided by a symmetry plane perpendicular to the axis of rotation, there will be a single resultant and a resultant couple; this couple can again be resolved in two couples perpendicular and parallel to the single resultant; the parallel couple may then be combined with the single resultant to another single resultant, and we have finally one single centrifugal force and one couple at right angles to the single force. The direction of the single force will not generally pass through the center of gravity of the body, but it will necessarily be equal in magnitude to the centrifugal force of the whole mass collected at the center of gravity. It is, therefore, not universally true that "The whole centrifugal force of a body of any figure, or of a system of connected bodies, rotating about an axis, is the same in *amount* and *direction* as if the whole mass were concentrated at the center of gravity of the system." (Rankine.)

The general case would be fully considered in a purely scientific investigation, but it is of no consequence in mechanical engineering, and a closer investigation would therefore not be in place here. It will in no case be correct to use the "radius of gyration" for the calculation of centrifugal force.

Ridgway, Pa.

LETTERS FROM PRACTICAL MEN.

The Newspaper Man Writes About a Machine Shop.

Editor American Machinist:

One of the leading Chicago morning papers has for several months past been running through its columns a series of articles entitled "Shop Talk, or Wonders of the Crafts." Many of these articles have been read with much interest by the general public (including myself), who have derived therefrom much information regarding the various trades. That the various articles are written by men who are authorities on the various subjects presented, and that their strict accuracy in detail can be relied upon implicitly, is proven conclusively by the following extract from one which appeared in a recent issue.

The subject under consideration in the particular article referred to, is the general repair shop in the small town. An extract from it is as follows:

"The principal machines in a repair shop are the 'shapers,' the 'engine lathes,' the 'drill presses,' the 'rollers' and the 'die cutters.'

"A 'shaper' is a powerful machine, and, as its name implies, is used for shaping, and sometimes planing, all sorts of pieces of flat and square steel, iron, brass, bell metal, etc. It is frequently in request for cutting keys for shafting.

"A favorite lathe is the 'engine lathe,' which can 'turn' pieces of metal from one-sixteenth of an inch to 21 inches in diameter, and of any length up to 12 feet. The speed is regulated by the size of the pulley used, six sets being attached to each lathe, and the speed varies from 10 to 100 revolutions a minute. Usually the larger and heavier the 'turning' is, the slower the 'turning' revolves. A 'handy' engine lathe is that which 'takes in' a circular 'turning' all the way from 1 inch to 5 feet in length and from one-sixteenth of an inch to 16 inches in diameter.

"A 'drill press' is used for boring holes of all sizes and shapes, from .32 of an inch upward. Such a 'press' weighs a ton or more, and it is one of the most useful machines in the shop."

"Here and there are to be found rollers, for rolling sheets of steel, iron and brass. One set is used solely for making smoke stacks for traction and stationary engines at saw-mills and at factories where the smoke is carried up in sheet-iron stacks. The rollers are often in use, and it is an interesting sight to watch them roll up tons of sheet iron as easily as a baby could twist a piece of paper around its finger.

"Emery wheels of different sizes and degrees of hardness are employed to grind down spheres and smooth off rough places. In a week's time one wheel may be used on three hundred jobs, not more than nine or ten being alike.

"In the blacksmith's department the forgings are made. Welding is a daily occupation. Inventors, including the young man who dreams that he has discovered perpetual motion, come in and have queer shaped forgings made. Generally they furnish wooden patterns."

Some of the information given in this extract will be entirely new to most machinists. It is of great interest to learn that a shaper is used for "*shaping* all sorts of pieces of flat and square steel, iron, brass, bell metal, etc." This is on a par with the definition of a "butler" as "a man who

butlers." I had always labored under the impression that the average shaper was not a very powerful machine, and that it was not such a particularly prominent tool in the average repair shop, as to be named first, but I am very glad to have learned otherwise.

It is also very interesting to learn that the engine lathe is the "favorite lathe," and that it can turn up to 21 inches in diameter, and 12 feet in length. If it had not been for this accuracy of definition one might have supposed that some of the magnificent tools in the larger shops, which will take in pieces much exceeding the dimensions given, were engine lathes. It is very unfortunate that the article in queston does not tell us what these larger tools are. If the writer had not further stated that the speed of the engine lathe was regulated by the size of the pulley used, we might have gone on believing that the usual method of "regulating" was by changing the speed of the shop engine. Passing over the useful data regarding speeds, the statement that a "handy lathe" is that which takes in a "circular turning," is very startling, and we are very glad to know that it is not a square "turning" which is usually operated upon. We suppose that by the word "turning" the writer means the piece being turned. I think he must have gotten this expression from a mechanical dictionary, as I never saw the word used in this sense anywhere else.

The statement that the drill press is used for "boring holes of all sizes and shapes" is not as wild as it may seem at first sight. Anyone who has watched the eccentric wabblings of an illy-made flat drill in some of the so-called drill presses used in the country job shop, will be inclined to agree that the holes made with one of those drills *may* be not only of "all sizes" but pretty nearly of "all shapes."

As a piece of statistical information it is very useful to learn that one emery wheel may be used on 300 jobs in a week. This is at the rate of five jobs per hour for six days of ten hours each. It is too bad that the writer stated that "not more than nine or ten would be alike," as the choice of figures leaves one in some doubt as to his strict accuracy, and his numerical preciseness in other places is such, that for the sake of consistency it would have been desirable to have the same exactness obtain throughout the article.

The public was undoubtedly very glad to learn from this article that forgings were made in the blacksmith department; they might have supposed that they were made in the paint shop. That the very remarkable and unusual operation of welding takes place "daily" would undoubtedly be the means of drawing great crowds to the machine shop described, if, unfortunately, the writer had not neglected to indicate its location. We do not know whether the writer of this article intends to say that "welding" is done *only* once a day or not. This, however, is a fair inference from his statement.

In a part of the article which I have not quoted, the reporter gave an extremely exhaustive list of the articles under repair or "waiting their turns to be fixed," including a hundred or more items. This categorical statement is very necessary as it indicates so precisely and accurately the scope of work and the range of usefulness of a repair shop, which extends from repairing "two pieces of logging chain which had been snapped asunder" to adjusting "a civil engineer's level." Another article undergoing repair was "a letter-press book."

After reading the article referred to, with its apparent accuracy of statement and real inaccuracy as to facts and its distortion of the relative values of things, one's faith in the value of the daily newspaper as a source of information is not apt to be increased. I had read some of the previous articles on subjects with which I was not familiar, with considerable interest, but after reading this one on the machine shop, the question at once arose as to how much of the alleged information contained in the others was to be relied upon. If the proportion of misinformation and truth is the same in the other articles as in this, the applicability of Josh Billings' statement that "it is better not to know so many things than to know so many things that aint so," will be so evident as not to require pointing out. A. J. SHAW.

Muskegon, Mich.

A Safety Valve on the Monkey Wrench.

Editor American Machinist:

The monkey wrench has sometimes been hung on the safety valve, but it does not seem to be on record that a safety valve has ever been applied to the monkey wrench. It must have occurred to many a thinker that the position of the monkey wrench is unique in the field of mechanics and engineering. It is of wide and ready adaptability and is often applied in positions of great responsibility, yet it is entirely free of accountability. The shovel can only lift its shovelful, and the shovelful stands in evidence. The crowbar can lift no more than the weight to which it is applied; but when a monkey wrench is used to tighten a nut there is no check upon and no evidence of the force exerted. This may entail the most serious consequences, and especially on account of recent developments. In the AMERICAN MACHINIST, June 20th, Prof. De Volson Wood, in computing the strength of a stud bolt used to hold on a cylinder head, after having figured down the effective strength of the bolt as 10,000 pounds per square inch, then says: "Since the bolts will be subjected to an initial tension due to screwing up the nuts, which amount cannot be easily computed, we will call the remaining strength 6,000 pounds." Now, it is very evident that with a safety valve upon the monkey wrench it would be very easy to compute the initial tension put upon the nuts, provided that the pull upon the wrench coincided with the adjustment of the safety valve, and of course it could not exceed that. It would also seem to be very evident that in a case like this a safety valve on the monkey wrench would be an absolute necessity, as the strength remaining in the bolt available for holding down purposes would depend upon the amount abstracted for the initial tension. The safety valve on the wrench would practically be also a safety valve on the bolt.

I have thought a little upon this subject of bolts at different times, but always in my simple way. I have imagined a vertical cylinder and a head without weight upon it, and studs and nuts holding the head down. I have considered only one of the bolts at a time, and it has always seemed to me that when a bolt (or nut) was tightened down, if there was no pressure in the cylinder, the top of the cylinder would press up against the head as hard as the nut would press upon the top of the head. If the nut was tightened down to a pressure of 5,000 pounds upon the head, the end of the cylinder would also press up with a pressure of 5,000 pounds. If, now, we began to get a pressure in the cylinder exerted upward against the head, say amounting to 4,000 pounds, it has seemed to me that in that case the end of the cylinder would only press upward with a force of 1,000 pounds, and these combined forces would balance the 5,000-pound downward pressure as before. Without submitting any more illustrations, it has always seemed to me that the initial tension of the bolt should never be deducted from its effective strength. So long as there is any doubt about this matter there should certainly be a safety valve on the monkey wrench. TECUMSEH SWIFT.

Tempering Steel.

Editor American Machinist:

As tempering is a very ticklish question to argue about, I will not by any means say "this is the way to do it," but simply make a few suggestions, and tell how I do it.

By working in many shops in different parts of the Union, I have tried nearly all schemes for cooling steel quickly, from a patent concoction of acids we had down at Edison's to cow urine, which I saw used by a blacksmith down in Texas. But after trying them all, I would recommend clean rain water, the older the better.

I have a big barrel I filled two years ago, and I keep it covered up so nobody can wash his hands or squirt oil in it.

Heating the steel in a common forge with smith coal is a risky undertaking, at least with certain brands of steel. Use charcoal at all events, and if it is an expensive die or tool, lay it in a closed box with bone dust, burn charcoal, and keep a slow but steady fire for an hour or so.

A good many tools are spoiled before they are tempered. Just as great care should be taken when heating the steel for annealing as for tempering. If the steel is heated too long, or burnt in annealing, it will show a coarse grain after it is tempered, *i. e.*, when corners drop off by using it. In die work we are liable to get the punch to fit too "quick," but hammering it cold will not help it. It may not show either before or after it is tempered, but the grain is cracked, and in punching will always chip off. This should be remembered in forging tools: As the steel gets cooler strike quicker and lighter blows.

In heating the steel I suppose everybody is not so well fixed as I am myself at present. I have an oil furnace 12 feet square which is used all day for tempering springs, and as it keeps a good heat for five or six hours after the oil is shut off, I can do my tempering during noon hour, or in the evening without extra expense. The furnace has a nice smooth floor, with two doors on each side, two 12 inches square, and two 10 inches high by 20 inches wide. In the center of the furnace I have a row of bricks, so as to keep one side hotter than the other.

Now when a die is done I first fill all stripper holes, and any other holes or crevices that are liable to break, with fire clay; the fire clay will keep the water out, and save many tender corners. Then I put the die on a straight cast-iron plate, and stick them both in on the cooler side of the oven; the cast-iron plate will prevent the die from coming in contact with the hot bricks, which is liable to heat the corners too fast. Now I shut off the oil, as the blast is not good for the steel, and as the die gets dark red, I push it over to the other side to get the final heat.

The color the steel ought to be now is a difficult thing to explain, as there are many kinds of red, seen through different eyes, and every brand of steel requires a different kind of red heat. But experience will tell you that all steel ought to be plunged into the water at the lowest heat it will get hard at. The tool ought to be left in the water at least half an hour before taking it out, and then drawn on a straight and smooth cast-iron plate.

Many punches may be tempered like a chisel, but the whole punch ought to be heated and then immersed in the water over the shoulder, and then lifted slowly out, so as not to crack at the water line.

How many forged cutting-off tools are not cracked at the shoulder? I stick half of the tool in water with cutting edge down, and in about 45-degree angle. If it is good steel, forged properly, and not overheated, it will save a lot of time in the lathe or planer. We must not judge a man by his looks, neither a die; it is not the die that has been ornamented with an oil stone, and with blued stripper screws, that is always the best. A die that will stand up to the work and punch out thousands of blanks without grinding every few hours, is the one that is paying its labor cost. P. D.

Square vs. Angular Screw Threads.

Editor American Machinist:

A good deal has been said in your columns concerning square and angular-threaded screws. Anyone who has not given the subject much thought might still be at a loss to make a choice between the two forms.

I am satisfied that I shall not be able to settle this question; however, may offer a thought or two.

All three forms, the square, half-V and V threads, are good, I think, in their proper places. The purposes for which they are intended should govern their selection, and if in doubt as to fitness, the one easiest made may be employed.

But few, these days, think of using a square thread on lead screws for lathes, for the obvious reasons: The half-V does not weaken the screw so much as either of the others. Then it is some easier, I think, to make a good smooth job of this form. Besides backlash may be taken up easily by closing the nut which is usually in halves, and should it be desirable to repair such a nut by filling with babbitt metal, the shape of thread facilitates this operation.

On the other hand, those who have used square-threaded bolts and nuts for binders on lathe and planer tool posts, will agree with me, I think, that they are better than either of the other kind. While for ordinary bolts and set screws no one would think of anything but a V-thread. The square thread is also good in lathe rests, cross and down feeds of planers, etc., where end play or lost motion is objectionable, and it is clear that with an equal amount of wear this will be the greatest with the angular thread.

It is not probable that square threads are going to be abandoned. The fact is they would doubtless be in more general use were not taps of this kind so expensive and so liable to damage by use.

It is no doubt best to make such taps comparatively short, and in sets of two or three, rather than risk the breakage of longer ones. By thus roughing out a nut with the first taps the finishing one will do better work and retain its form much longer.

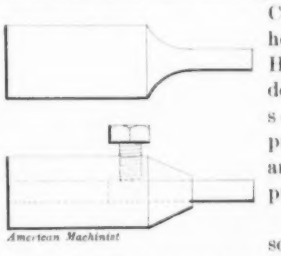
Where considerable length of thread in a nut is necessary, it is undoubtedly a good plan to make such nuts in two or three sections. This not only lightens the work of tapping but insures more perfect conformity in the pitch of the two threads. A discrepancy that is liable to exist, both on account of the effects of tempering the tap, and that of inequality of threads on the lead screws used to make the tap and screw which is to follow it. Such precaution is especially important, as I have found, in preparing a nut for babbitting. This I have done by boring away the old thread at intervals, leaving a narrow partition to separate the metal and prevent the hurtful effects of shrinkage lengthwise of the nut.

"QUIRK."

Small Punches, Annealing Steel, Etc.

Editor American Machinist:

We are having a good many punches to make for a sled factory to punch $\frac{1}{2}$-inch steel. Punch is $\frac{3}{16}$ inch diameter, fitted to power machine running at a good speed. Punches at first were $\frac{3}{4}$ inch diameter and $3\frac{1}{2}$ inches long, 3 inches by $\frac{3}{4}$ straight, $\frac{1}{2}$ or $\frac{3}{4}$ of length was turned to $\frac{3}{16}$ inch, and tempered as per sketch. But when end was broken there was quite a waste. So we have made a holder $\frac{3}{4}$ by 3 inches, with a $\frac{3}{16}$-inch hole clear through. In this we put a tempered pin to fill hole loosely, and prevent punch pushing up, punch being kept from dropping out by a $\frac{1}{4}$-inch set screw. Now this would work to a charm, but the punches will break at times badly. Strike square in die, die relieved. Have tried drill rods and all degrees of temper. Can any brother help us out? Have tried a double shear and square cut punch, forged and not forged punches.



Also, will someone give me best way to anneal tool steel for lathe work from 1 to 4 inches diameter?

We make a good many patent axes for stone planer work; they are 3 and 4 inches diameter, with V-grooves cut in face, some round, others lengthways, standard 60° Vs, some 6, 8 and 10 to the inch. Rollers have to be bored whole length true for 1 inch shaft. How would you do this? May we not hear from our brother workers?

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A New Manager Not Wanted.

Not long ago the proprietors of a machine shop, not far from New York, being dissatisfied with the returns received from the establishment, and not knowing much to speak of about the business in a practical way, concluded that in order to get better returns it would be necessary only to get a better man for manager. The manager they had had been in charge of the shops for some time and was a practical man—capable of contracting for and seeing work through the shops and properly finished—a member of the A. S. M. E.

The proprietors began making some inquiries about a man, and were finally referred to another and very similar kind of man—also a member of the A. S. M. E., who happened to be looking for a situation. This man was not acquainted with the shops or anyone connected with them, but made an investigation which took the form of a visit to the establishment and a talk with the manager about a possible contract and the adaptability of the plant to the proper execution of the work.

As a result of this visit the investigator saw that in order to put the place upon a paying basis a certain amount of outlay would be necessary for new and more modern equipment, and that the plant was being handled very well considering the opportunities of the man who handled it.

The proprietors were then informed of the true state of affairs and given to understand just what would be necessary and how much it would cost, and upon their refusal to make the investment they were informed that the man they already had was doing as well as anyone could do probably, and that they had better make no change. The old manager, therefore, still retains his place so far as we know, as he ought to.

We mention this incident because we think the affair was much better conducted by the man who was looking for a place than such matters are generally conducted. He could easily have secured the situation, but by taking it he would have been doing his fellow engineer an injustice, and in the end would have been no better off himself. In too many such cases the man who hears of a situation that is obtainable obtains it first and then tries to get things into decent shape afterwards, the result being the frequent changes of *personnel* which we sometimes see in manufacturing establishments, and which is either one of the causes, or one of the effects of a declining condition.

There are several questions of professional ethics as well as business policy involved in such an affair.

Annealing Steel.

Some items of good advice need to be repeated over and over again, not only for the benefit of the constant influx of new scholars, but because the older ones are so negligent and thoughtless. It should not be necessary to be reiterating the conditions of success in the annealing of steel only that no operation of the shop, certainly none so important, is, in general, so slackly conducted. To anneal a piece of steel it should be heated slowly, as uniformly as possible, and to a good, bright heat, but not hot enough to injure the steel. The piece should then be cooled off very slowly and it will be annealed. Everybody knows that, and few know any more than that about annealing steel. All understand that the critical part of the operation is in the cooling. Too many forget or ignore the fact that care in the cooling of the steel should begin at the very beginning, and that it is most important at the beginning. Much parade is made of devices for securing slow cooling, but too often before they become operative the steel has already been fatally chilled. We have known a large iron box of lime provided for annealing steel, with a tight iron cover to it, and we have known pieces of steel to lie in it 12 or 14 hours, or even 36 hours over Sunday, and then be so hot as to require cooling in water before they could be handled, and after all they would not be very satisfactorily annealed. The box would be stuck away in the farther corner of the shop, and the piece of steel when heated would be handled with a pair of cold tongs, and rushed through the cold air and laid in the cold lime, and then it would be declared that every possible precaution had been exercised. The time it would take for the piece to get entirely cool would prove it. But either the tongs, or the rush of air, or the cold lime may have been enough to defeat all the subsequent operation. Too much care cannot be exercised in every detail of the cooling from the very first of it, and especially at the first of it. Steel can be buried up right in the blacksmith's fire where it is heated, and because it is then secure from any chilling or sudden cooling at the first, be annealed very quickly. The annealing is completed before the steel is half cooled. We have an illustration of this in what is known as the water anneal. Many mechanics, perhaps most mechanics, have an idea that there is a certain critical temperature at which the steel can be suddenly cooled and annealed, and that in this resides the trick of water annealing. The simple fact is that when steel is cooled so that there is absolutely no color visible in the dark the operation of annealing is completed and no suddenness of cooling after that can affect it.

The Decimal Measurement of Angles.

A scheme for the measurement of angles by a decimal notation is to be presented at the coming Geographical Congress in London. It is proposed to divide the circle into 100 *cirs* with decimal subdivisions of *decicirs*, *centicirs*, *millicirs* and *demicirs*. An angle of 7 cirs, 77 centicirs and 51 demicirs would be written 7 x 7751, the x being the designation for *cir*. From experiments made in Italy it is claimed that $\frac{9}{7}$ to $\frac{1}{3}$ saving is effected by the use of this system in astronomical calculations. This is getting the matter down fine, and we have nothing to say as to what star-gazers may think of it or do with it, but we must protest in advance against any such foolishness in mechanical or engineering matters. The simple fact that the angles of 30 degrees and 60 degrees cannot be perfectly expressed in this notation is fatal to its adoption. The system, of course, would apply and is intended to apply to the measurement of time, and our clocks would have to be built over again. Think of dividing the 24 hours of the day decimally. The man who now works ten hours a day would then have to work 4,166 + of whatever the unit may be designated. He would certainly have a reasonable excuse for cutting it down to 4,000 which would save him about 24 minutes a day.

Learning About Centrifugal Force.

It probably seldom happens that any article we publish is of interest and value to every reader. This week we have an article upon "Centrifugal Force," which we trust will help some of our readers to a better grasp of the subject. It will be noticed that Mr. Begtrup has to commence with his little ball and his piece of string, just as all of his predecessors have done. We cannot suppress the thought that a great many shot and several yards of string have been wasted since the first teacher began.

If any simple force must always act in a straight line, and if any curvilinear motion is a result of two or more forces (or resistances) in different directions, and if we want to begin with the simplest case and add our complications after, why would it not be best to begin our study of centrifugal force with a case of rectilinear motion? Put the pupil upon a cable car, and if it be crowded so much the better. Let him stand up close to the front end of the car, and then when the car shoots suddenly around a sharp curve, and he is pitched into the lap of the lady in the corner, it will not be necessary to remind him thereafter of his first lesson in centrifugal force.

This is not a frivolous illustration. We have an actual exhibition of centrifugal force under actual conditions instead of having to assume a practically impossible one. We have a body actually moving in a straight path, and the centrifugal force is the force necessary to divert the moving body from the straight path to the circular one. From our standpoint upon the car, the car itself may be assumed to be stationary and the track to be moving, and then the force necessary to be applied to convert the rectilinear motion into the curvilinear will be applied by the side of the rail at the curve. If we look at the inside of the outer rail at the curve and see how rapidly it is worn, we may have a better realization of the intensity of the force. If we happen in the course of the trip to pass two curves of different radius, or if, in the busier and more crowded part of the city, the car is driven by a slower running cable, these conditions, with the additional one of a constantly changing load of passengers, would seem to offer all the particulars necessary to a complete understanding of the various exhibitions of centrifugal force. It might be worth while for some enterprising individual to work this matter up along the lines here suggested.

"Useful Citizens."

Among the brightest of our exchanges is *Dixie*, of Atlanta, Ga. It always provides something provoking thought. Here is a specimen:

"Our people must bear in mind that cotton-mills alone will not make a prosperous community. There are one or two towns in the South that are cotton-mill poor already. Cotton-mill labor does not add greatly to the useful population of a town. These people are ignorant, and capable of earning but the poorest wages. Their poverty and ignorance prevent their development, and they remain always the same. Well-paid mechanics benefit a town because nine out of ten of them become useful citizens and take their place in the business and social organization of the town."

We might as well say that banks alone will not make a prosperous community. But banks cannot and do not exist alone. Neither can or do cotton-mills exist alone. Neither do useful citizens belong to any special class. The most useful citizens are those who are most useful to themselves, who manage to get the most that they can for themselves out of this life of ours, and they may be and they are in the cotton-mills as well as in the machine shops. A marvelous industrial development is in progress in the South. Cotton-mills and other industrial establishments are springing up with wonderful rapidity as the nuclei of prosperous communities. We were disposed to rejoice at this, but it seems that the apparent activity is in the accumulation of the poor, the ignorant and, above all, the hopeless. Humanity forbids us to rejoice at such "progress," and we must do all that we can to deter all unfortunates from becoming participants. It is good news to us that of well-paid mechanics nine-tenths of them become useful citizens, and now we need only to be assured that nine-tenths of them are well paid, as we have hope that they will be in the good time coming.

As a matter of business *Dixie* should be scheming to find some little hope for cotton-mill labor, so that these people may not be always ignorant, so that they may earn something better than the poorest wages, so that through poverty and ignorance they may not be forever the same, so that they may become consumers to an extent somewhat commensurate with their productive capacity.

We have before us a list of more than 150 large firms whose recent advances in their rates of wages to employes have found a record in the columns of the daily press. The number of workers benefited is considerably over a quarter of a million, and the average advance for the whole is nearly 12 per cent. The list of industries seems to embrace nearly every line of activity, with, of course, iron and steel and machinery at

the head. Our list alphabetically arranged is like this:

Barbed Wire,	Iron and Steel,
Bells,	Knit Goods,
Blankets,	Linen,
Blasting,	Machinery,
Boilers,	Mining,
Bolts and Nuts,	Paper,
Brass Works,	Pipe Works,
Bunting,	Pottery,
Cassimeres,	Saws,
Cloaks,	Shoes,
Coats,	Shovels,
Coke,	Silk,
Copper Mines,	Smelting,
Cotton Mills,	Steam Engines,
Electrical Appliances,	Steel Springs,
Elevated Railways,	Wire Goods,
Fabrics,	Wire Nails,
Flannels,	Weaving,
Furnaces,	Woolens,
Garments,	Zinc Works.
Hardware,	

A number of "manufacturing companies" do not in their title indicate their product.

Death of Alton J. Shaw.

Mr. Alton J. Shaw, M. E., president and engineer of The Shaw Electric Crane Co., Muskegon, Mich., died in that city on June 22, 1895, of appendicitis after an acute illness of three or four days. Mr. Shaw was born January, 1858, graduated B. M. E. from the Maine State College 1879, from 1879 to 1882 was draftsman for the Chandler Water Motor Co., 1882 superintendent for R. Gardner & Son, Montreal, P. Q., 1882 to 1883 draftsman Yale & Towne Mfg. Co., 1883 to 1885 draftsman Brown & Sharpe, 1886 to 1889 with the E. P. Allis Co., and from 1889 manager of The Shaw Electric Co. This was almost an ideal training and experience to equip a man for a life work as a mechanical engineer, and the position attained by Mr. Shaw at so early an age showed that it could not well have found a better subject. Mr. Shaw was a member of the American Society of Mechanical Engineers. An interesting "practical" letter from him appears in the regular course of events in our present issue. He was not a lover of a crowd, and avoided rather than sought society. He was a student and almost a recluse, and was passionately devoted to music. He leaves a wife and daughter.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(267) J. H. S., Greenland, Pa., writes: Please inform me how to find the pitch of a gear. *A.*—If you wish to find the pitch of a gear which has been made, use the following rule: Divide the outside diameter of the gear, that is, the diameter of the addendum circle, by the number of teeth plus 2, the result will be the diameter pitch, divide this by .3183, the result will be the circular pitch. If you wish to find the pitch for a new gear, then the pitch is determined to suit the work the gear has to perform. 2. How many pitches are there? *A.*—The number is unlimited. 3. How can I find the number of teeth that will go in a gear? *A.*—Divide the circumference of the pitch circle by the circular pitch, the result will be the number of teeth. We would advise you to read the "Practical Treatise on Gearing," published by Brown & Sharpe Manufacturing Company, Providence, R. I.

(268) J. E. L., Hamilton, Ohio, writes: In your answer to Question 254 you give a constant 7,639 for determining the area of a steam port. Kindly inform me how you get that constant; and what velocity of the flow of steam have you adopted? *A.*—The velocity of the flow of steam should not exceed 6,000 feet per minute, this velocity we have adopted; hence the area of the steam port is found by the following formula:

$$\frac{D^2 \times .7854 \times S}{6{,}000} = A \qquad (1)$$

in which D = diameter of the cylinder in inches, S = speed of piston in feet per minute, and A = the area of steam port in square inches. Dividing both sides of the equation (1) by .7854 we get,

$$\frac{D^2 \times S}{7{,}639} = A$$

which is the formula we have given in the answer referred to.

(269) W. D. O., New Bedford, Mass., writes: I am trying to collect a number of books which will be useful in my chosen work, that of a marine engineer. I have catalogs of books from various publishers, and when I send for a book as per catalog, I find it to be of no value to me in one way, as I am not a graduate of a technical school, and do not understand higher mathematics sufficiently to read these books, although I am now studying the higher branches of mathematics. Kindly help me in the selection of books and give the title of a book which treats on the construction of boilers, with rules needed for designing them, one which is illustrated preferred; a good natural philosophy; a book treating on the marine engine, which also gives some information in regard to babbitting; a work on electricity; and one on hydraulics, and other books such as will be useful to me. *A.*—Your course of studying the higher branches of mathematics so as to enable you to read with profit some of the advanced works on engineering is commendable, and our advice is to persevere in this course, and you will soon find the great advantage you have gained. However, your trouble in reading the advanced works may be more imaginary than real; many of the formulæ given in advanced works may appear to require a knowledge of algebra to read them, when, in fact, such is not the case; with a good knowledge of ordinary arithmetic many of these formulæ can be read with ease. A formula is nothing more or less than a shorthand way of expressing a rule, or we may say, it is a symbolic expression of a rule; in these expressions letters are used to represent certain quantities, and the significance of each letter accompanies the formula; hence, as far as the use of letters is concerned, there should be no difficulty in reading the formula. The operations are indicated by the ordinary signs of arithmetic, and those acquainted with this branch of mathematics can readily interpret their meaning. The letters and signs together are called symbols. Very little practice will enable you to read many of the formulæ in advanced works. Sometimes authors show the way of deriving a practical formula from a fundamental formula or law; of course, in cases of this kind a knowledge of algebra is necessary, but in many cases not to a great extent—a knowledge of equations of the second degree is frequently sufficient. Now, in regard to the books: "Treatise on Steam Boilers," by R. Wilson, is a good book, but it does not contain as many illustrations as you may desire; "Steam Boilers, Their Design, Construction, and Management," by W. H. Shock, is another good book, and contains many good illustrations of marine boilers. "Elements of Natural Philosophy," by E. M. Avery, may suit you. For marine engineering we should advise you to read first the "Text-book on Steam and the Steam Engine," by A. Jamieson; then take up "Steam and the Marine Steam Engine," by John Yeo; and finally take up "Manual of the Marine Engine," by A. E. Seaton; this book contains many formulæ and algebraic expressions and may give you some trouble in studying it; it is, however, a standard work on this subject. For the study of electricity, get "Electricity and Magnetism," by S. P. Thompson; and for hydraulics get the "Treatise on Hydraulics," by M. Merriman. In connection with these subjects study "Principles of Elementary Mechanics," by De Volson Wood; and "Mechanics of Materials," by M. Merriman.

(270) Engineer, Fort Wayne, Ind., writes: We have an externally fired tubular boiler to design; it is to furnish 10,000 pounds of steam per hour at 125 pounds pressure with a feed-water temperature of 100° Fahr. Please give a method for determining the size of this boiler. *A.*—When water is evaporated from a feed-water temperature at 212° Fahr. into steam of the same temperature, one pound of coal will evaporate, say, nine pounds of water per hour. Taking this ratio as a standard, we must first find the amount of water evaporated from and at 212 degrees equivalent to 10,000 pounds of steam per hour at a pressure of 125 pounds. We take this to be the gage pressure. In computations of this kind, we must use absolute pressure, which is, in this case, $125 + 15 = 140$ pounds. The number of heat units in a pound of steam at a pressure of 140 pounds is 1,221.5; this can be found in steam tables generally given in books treating on the steam engine; the feed water at a temperature of 100 degrees contains 100 units of heat (this is not quite correct, but is sufficiently close for ordinary purposes); hence subtracting 100 from 1,221.5 heat units, we have 1,121.5 heat units which must be furnished by the coal. It requires 966 heat units to evaporate 1 pound of water into steam from and at 212 degrees; hence $1{,}121.5 \div 966 = 1.16$ pounds of water, and for 10,000 pounds of steam at a pressure of 140 pounds we must evaporate an equivalent of $1.16 \times 10{,}000 = 11{,}600$ pounds of water from and at 212 degrees. Since 1 pound of coal will, under the latter condition, evaporate 9 pounds of water we have $11{,}600 \div 9 = 1{,}289$ pounds of coal required per hour. Generally 15 pounds of coal is burnt per square foot of grate surface with natural draft; hence for this boiler $1{,}289 \div 15 = 86$ square feet of grate surface will be required; there should be about 32 square feet of heating surface per square foot of grate surface when iron tubes are used; hence $86 \times 32 = 2{,}752$ square feet of heating surface will be required. The aggregate cross-sectional area of the tubes should not be less than one-eighth, and need not be more than one-sixth of the grate area, we believe that one-seventh is a good proportion; hence the aggregate cross-sectional area of the tubes will be $86 \div 7 = 12.28$ square feet; dividing this area by the inner cross sectional area of tube will give the required number of tubes. To find the diameter of the boiler lay out the number of tubes on a sheet of paper and thereby find the suitable diameter of shell, remembering that the top of the upper row of flues is generally placed at three-fifths of the diameter of the boiler. We may say here that in spacing the number of tubes it will be found that more than one boiler will be needed for the quantity of steam demanded. The total tube-heating surface in this class of boilers is usually about one-eighth of the total heating surface required; hence knowing the number of tubes, and the diameter of tubes being determined, the length of tubes, and therefore the length of boiler, can easily be found from the above data. The bridge wall at the end of the grate should be built to such a hight that the area of the passage is not less than one-eighth or more than one-sixth of the area of the grate, and when possible the distance from top of furnace to the top of bridge wall should be sufficiently great to allow a man to pass into the combustion chamber. 2. Please give the quantity of water usually evaporated per square foot of grate surface, also per square foot of heating surface, in this class of boiler. *A.*—This is easily obtained from the preceding answer, in which we have found that 11,600 pounds of water must be evaporated, and for this 86 square feet of grate surface is required; hence $11{,}600 \div 86 = 135$ pounds of water per square foot of grate surface will be evaporated. We have also found that 2,752 square feet heating surface will be required; hence $11{,}600 \div 2{,}752 = 4.2$ pounds of water evaporated per square foot of heating surface. 3. Is 1 pound of steam equal to 1 pound of water? *A.*—Yes. 4. If the pressure be increased to 150 pounds how would it affect the size of boiler for the same output? *A.*—If the same number of pounds of steam is to be furnished under a pressure of 150 pounds the grate surface and consequently the boiler will have to be a little larger. 5. The Centennial standard for 1 horse power is 30 pounds of water evaporated per hour from feed water at a temperature 100° Fahr. into dry steam at 70 pounds gage pressure. Now when I want to find the horse-power of a boiler at different working pressure than this, the temperature of the feed water remaining the same, how should I proceed? *A.*—See answer to Question 210, in our issue of May 16th, current volume.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 533.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Cam-Milling. Machine Tool Works, Newark, N.J.

Marine Iron Works, Chicago (new catalog).

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

Best Presses and Dies for all sheet metal work, Ferracute Machine Company, Bridgeton, N. J.

Air compressors for all purposes and pressures. Clayton Air Compressor Wks, 28 Cortlandt St., N.Y.

Engine Castings, 1 to 6 Horse-power Vertical. The Humphrey Foundry, Bellefontaine, Ohio.

Foster Engineering Co., Newark, N. J., Pressure Regulators, Reducing Valves, Pump Governors.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

Machine work solicited; complete equipment modern machine tools; patternmaking, designing, experimental work; tech. assistance if required; best facilities & very reasonable prices. P. Pryibil, 512-524 West 41st St., N. Y.

Just Published—"The Modern Machinist," by John T. Usher. Price, $2.50. Each of its 257 illustrations represents a new device in machine shop practice; a new book from cover to cover; agents wanted in every machine shop; send for special illustrated circular. Norman W. Henley & Co., 132 Nassau street, New York.

Detroit Meeting of the American Society of Mechanical Engineers.

(*Continued from page 525.*)

The next paper was, "The Effect of Length of Specimen on the Percentage of Ductility." By R. C. Carpenter, Ithaca, N. Y.

This is a record of a series of tests undertaken to ascertain what difference in the percentage of ductility is due to varying lengths of specimens. Previous to the tests it had been determined that the extension per unit of length at maximum load is constant throughout a specimen, and hence is independent of its length. The conclusions in this paper are: that a standard *size* of specimen is necessary to give definite value to the percentage of ductility; that the ultimate strength of boiler steel, or of homogeneous wrought iron, is independent of the length of specimens from 2 to 8 inches; that percentages of elongation taken at maximum load are more uniform than percentages of ductility taken after rupture; that percentages of elongation at maximum load are less than percentage of ductility taken after rupture, but are nearer equal as the specimens are longer.

Mr. Henning, in discussing the paper, said it would be better to use the term "elongation" instead of ductility, as the former was more exact, and Professor Carpenter agreed to this.

The next paper was, "A T-Square and its Mountings." By W. A. Gabriel, Elgin, Ill.

This is a very elaborate T-square mounted upon a guide bar attached by adjustable brackets to a permanent drawing table. The head of the square has rollers that enable it to move easily upon the bar. The blade has a rib or trough for instruments, etc. This blade is secured to a geared segment operated by a worm to adjust the blade to any angle. Many refinements of detail are mentioned in the description.

There was no discussion.

The next paper was, "The Efficiency of Boilers—A Criticism of the Society's Standard Code of Reporting Boiler Trials." By F. W. Dean, Boston, Mass.

The efficiency of a boiler is the ratio between the total heat which any given coal can generate by complete combustion, and that part of it which is absorbed by the water and steam heated and generated. The report of the committee of this society says that the relative economy of boilers is expressed by the number of units of evaporation obtained by a pound of combustible. But combustible as well as coal varies in heat value per pound. Efficiency may be determined by knowing the number of heat units that a pound of coal and a pound of combustible can give out, and the number of heat units that the water has received. The heat that goes up the chimney belongs to the possible heat of the coal.

The writer then suggests many changes in detail in the society's standard form for reporting trials, and offers an amended blank, and then a resolution looking to the appointment by the society of a committee to propose a new standard for boiler tests.

Mr. Geo. H. Barrus contributes some remarks generally supporting the author's position, and endorsing his recommendation of a committee to revise the standard.

This paper was very vigorously discussed, and the idea of considering combustible in boiler tests condemned as humbug. It was shown how where two boilers, under competitive test, using the same coal, were so managed that one of them showed the highest evaporation per pound of combusti-

ble, while the other showed the highest evaporation per pound of coal.

The plan that seemed to be most in favor among those who discussed the paper was to have certain selected coals in the different sections of the country as standards, and refer all tests to them, and it seemed to be the general opinion that tests must be based upon coal consumption. As Robert W. Hunt expressed it, the boiler user cannot buy combustible, but must buy *coal*. He gave an instance where by substituting culm for other coal the cost of steam making was much reduced, while at the same time the efficiency was also reduced.

The next paper was, "Force Required and Work Performed in Driving and Pulling Out Cut and Wire Nails." By R. C. Carpenter, Ithaca, N. Y.

Nails of each kind were driven and pulled by attachment to testing machine, and diagrams and tables made of the results, which are: that much more force is required to drive a cut nail a given distance than a wire nail; more force is required to start a cut nail than to drive it, and always much more than is required for a wire nail; the work in *inch pounds* is much more in driving cut nails than in driving wire nails; the work in *inch pounds* in pulling cut nails is about equal to that for wire nails; the relative efficiency, or the ratio of the work of pulling to that of driving, is much higher for the wire nail than for the cut nail.

"New Forms of Friction Brakes." By W. F. M. Goss, La Fayette, Ind.

No brake known fulfills all the conditions required. Prony brakes give trouble by vibrating, and an improved form is shown where a pendulum near a graduated arc indicates the power and checks vibration. Six other brakes are successively described, concluding with the Alden brake, which seems to give better satisfaction than any other.

Professor Jacobus, in discussion, showed a form of rope brake used by him, in which two strands of rope were passed about the wheel, and a frame attached by which tension could be adjusted; this frame resting upon a platform scale.

Such a brake he said had worked well when absorbing 150 horse-power on a 72-inch wheel for 6 or 7 hours.

The next paper was entitled "A Horse-power Planimeter," by E. J. Willis, Richmond, Va.

The instrument will form the subject of an illustrated article, and the paper need not be further referred to here.

"A New Coal Calorimeter." By R. C. Carpenter.

This paper describes an instrument for determining the heating value of coals. In principle it is a large thermometer, the combustion taking place in the bulb and the heat being absorbed by the liquid in the bulb, the heat causing the liquid to rise in a glass tube extending upward outside. The fuel is placed in a dish in the bottom of the combustion chamber, and is fired by an electric current through a platinum wire, and oxygen is supplied through a tube. The discharge gases pass through a long coil of copper pipe. An elaborate description of the entire apparatus is given, and the mode of using it in detail, and various other forms of calorimeters are discussed.

"Tests to Show the Distribution of Moisture in Steam when Flowing Through a Horizontal Pipe." By D. S. Jacobus.

It has been known that in the flow of steam through a pipe the moisture is not evenly distributed, but is greatest at the bottom, and the present tests were made to determine to what extent this action takes place. Precautions were taken to thoroughly mix the moisture in the entering steam, and it was found that after flowing eight feet in a three-inch pipe, 95 per cent. or over of the entrained moisture could be drawn from the bottom of the pipe. A table is appended giving the percentage of moisture collected by a ¼-inch pipe with the steam at velocities in feet per second from 65 to 20, the percentage of moisture ranging from 45.6 to 100 per cent.

This paper was much discussed, and finally Professor Jacobus was asked how he would determine certainly the percentage of moisture in steam when it might be important to know. He thought the only practical means was by use of a separator, which would take out the entrained water.

At the close of this meeting the members adjourned to a small park near by, where an exhibition was given by the fire department to show the efficiency and usefulness of a system of piping laid under the surface of the streets and leading up from the river, where they are arranged to be pumped into by the fire boat "Detroiter." Some of these pipes are nearly a mile long, and they are eight inches in diameter. By this means the fire boat is made available for fires occurring within a much wider range of territory than would otherwise be possible.

THURSDAY MORNING'S SESSION.

The first paper at this session was "Analysis of the Tremont Turbine." By DeVolson Wood.

The author says that the Tremont turbine furnishes a coveted example for testing the theoretical formulæ for the proportions and deliverance of turbines, and proceeds to an analysis of the same in his characteristic manner. For obvious reasons this paper cannot be summarized or considered except as a whole, and we may be able to do this last in a future issue.

Professor Sweet called attention to the fact of the wheel's close conformity to the theory, and said it would be interesting to know whether the theory or the wheel had been constructed first.

"Rustless Coatings for Iron and Steel." By M. P. Wood.

The author defines paint, states the essentials of a good paint, discussing especially its covering power, and then its durability and the agencies tending to its destruction. The various materials used for paints are then examined in detail and the characteristics of each considered; the non-protective character of the iron oxide paints when applied to iron structures being especially insisted upon, and after that the valuable preservative lead paints are treated of. This elaborate paper, the third by the author upon the same general topic, is to be followed by a fourth, completing the series.

There was no discussion.

"A Piece-Rate System—A Step Toward a Partial Solution of the Labor Problem." By Fred. W. Taylor, Germantown, Philadelphia.

This paper describes a piece-rate system introduced by the author at the Midvale Street Works. It is in the orderly and exhaustive style exhibited in a previous paper by the same author upon a widely different topic. The peculiarity of the system seems to lie in a differential rate according to the rapidity or the perfection of the product, the rate being higher for quick work, or for the most perfect work, than for work that is inferior in either respect. The author fully believes in his system and seems to deal only with absolute knowledge gained by his own experience, chiefly at the Midvale Steel Works, where, by this plan, the output of the works was very much increased without materially affecting the total fixed charges, while the men at the same time were enabled to earn considerably more money than before. The essential points of the system seem to be in, first, accurately determining the possible capacity of a machine, say an axle lathe, and then paying a certain rate per piece when this maximum is attained; a lower rate being paid per piece for any production less than the predetermined amount. It was stated that this system had worked admirably in every respect, whether from the standpoint of the employer or from that of the employe.

The paper brought out a very long discussion. Mr. Penton, editor of *The Foundry*, speaking from the standpoint of a man who for five years had been at the head of an organization classed as a labor organization (machinery molders), said that when he thought of the many questions that he believed would be solved by this system—how it would have worked had it been applied to the settlement of the question settled by the military at Homestead, he believed the author was entitled to a very great deal of credit for the careful and conscientious study he had given the matter, and for making public the actual results in a trial which had extended over a period of years. He considered it a very important contribution toward the solution of the vexed questions which too often arise between men occupying the positions of employer and employe.

W. S. Rogers stated that he had tried the same system in Columbus, Ohio, in 1883, and it had not worked well. He favored the system of premiums devised by F. A. Halsey, and described in a paper presented at the Providence Meeting.

Mr. Kent had also tried the Halsey plan, but believed Mr. Taylor's to be an improvement upon it. He was glad that attention had been directed to such a matter, and believed it would not be settled by those whom he called "old-time mechanics," but by technical graduates, having a broader education. He thought technical schools should teach workshop economics.

The discussion drifted into the apprenticeship question, some of the members claiming there were no longer any apprentices. This brought out C. H. Norton, of Detroit, who spoke of the excellent results attained by the Brown & Sharpe Mfg. Co., with its apprentice system, and W. R. Warner, of Cleveland, who testified to the fact that such establishments as Brown & Sharpe Mfg. Co., Pratt & Whitney, and his own (Warner & Swasey) took apprentices, and got very satisfactory results from the practice. When his firm wanted a man for a responsible position, a former apprentice of theirs was usually chosen; their present superintendent, chief draftsman, and foreman having been apprentices in their shops. The fact that a man had served an apprenticeship in either of the other two shops mentioned was in itself a recommendation for him, and such men were taking the leading positions in the best shops.

Mr. Holloway commented upon the changed relations existing between apprentices and their employers due to the modern ownership of machine shops by corporations instead of by individuals who were themselves mechanics, as was formerly the case, and thought this had an important bearing upon the matter.

"The Down-Draught Furnace for Steam Boilers." By William H. Bryan, St. Louis, Mo.

This describes the down-draught boiler furnace, invented by M. C. Hawley, of St. Louis, which is claimed to have done more than any other mechanical device toward the solution of the smoke problem. In this furnace the fire burns downward, instead of upward, the coals being sustained upon grates which are water tubes connected with the water circulation of the boiler. The air enters the furnace above the fire, and passes down through it. Some of the coals drop down through the grate, and are burned upon a grate below with an upward draught, the gases from both the fires passing onward together to impart their heat to the boiler. 90 per cent. of the furnace work is usually done by the upper fire with the down draught. Records of tests are given, and results are tabulated.

In discussion Mr. Kent said that the main trouble with the boiler engineering of the West was in the fact that boilers were usually not large enough, or rather that there were not usually enough boilers in a plant to bring the evaporation per square foot of heating surface down to an economical rate. It should, in his opinion, be somewhat less than 4 pounds. Colonel Meir stated, however, that they had invariably got the best results with a considerably more rapid evaporation. Mr. Kent maintained that a high uptake temperature and high evaporation per square foot of heating surface always meant low efficiency.

"A New Shaft Governor." By E. J. Armstrong, Oswego, N. Y.

This paper briefly describes an improvement or modification of the fly-wheel governor mechanism which shifts an eccentric operating a slide valve. The shifting weight is a short solid cylinder rolling in a curved chamber filled with oil, the dash-pot action operating to check any too sudden or excessive movements. The governor resembles Professor Sweet's, except that within the weight the second rolling weight spoken of is placed, this shifting weight enabling a closer approach to isochronism than is otherwise possible, and very close governing.

The author states that it is possible to so adjust this governor that it will increase the speed of the engine with increase of load.

This last statement caused Robert Allison to say that he did not believe any centrifugal governor could be made to do this. He was open to conviction, but it seemed to him impossible that any governor should occupy two widely different positions at the same speed.

THURSDAY AFTERNOON.

From the hall the members went to the Detroit River and boarded the Detroit & Cleveland Steam Navigation Co.'s steamer, "City of Cleveland," a boat in all respects very much resembling the Sound boats plying between New York and Providence. The weather was much cooler than on previous days, and the trip to the St. Clair Flats, twenty-five miles from Detroit, with the fish supper at the Star Island House and the return in the evening, was perhaps the most enjoyable feature of the meeting.

A slight accident to the boat formed one of the features of the return trip, however. A tow was met in a narrow artificial channel, and in attempting to pass the boat was crowded over onto some piling at the side of the channel, and her starboard feathering paddle wheel struck the piling, bending the wheel, so that the end of one of the buckets had to be sawn off before the boat could proceed. The accident did not, however, prevent the boat from leaving for Cleveland at 11 P. M. on her regular trip.

FRIDAY MORNING'S SESSION.

The first paper taken up at Friday morning's session was M. E. C. Knapp's, entitled "A Method of Proportioning the Cylinders of Compound Engines," which had been crowded over from the previous session. The author briefly discussed a method of proportioning cylinders of compound engines, so that, as nearly as possible, the load will be equally divided between the two cylinders, and this equality of load would be maintained throughout considerable variations of load and cut-off, and the corresponding range of temperature would be an economical one.

In discussion, Mr. Stanwood expressed the opinion that the title of the paper was too broad, as it only touched upon one phase of the subject.

Mr. Rockwood thought that the figures given for cylinder proportions were in some cases not the best. When steam at low pressure was to be used he thought the ratio should be small, while if boiler pressure was high the ratio should be 1 to 9 or 1 to 10. He thought this question of proportion of cylinders had not been given the attention it deserved, and spoke of an arrangement for testing the matter at the Worcester Polytechnic Institute, where they had planned to run the different component parts of a compound engine at varying speeds for testing, by which plan they would virtually have varying ratios between the cylinders. He thought this plan would result in a better knowledge of the subject.

Mr. Kent called attention to the fact that both engines and boilers were usually tested at practically constant loads, even when it was known that in service the load would vary greatly. He thought tests should sometimes show which engine was most efficient throughout a considerable range of varying

loads, and which boiler was most efficient under varying rates of evaporation.

Mr. Stanwood endorsed this view, and said that the variation of engine loads was constantly increasing, owing to the demands of electric lighting and power service.

During the further discussion it was remarked upon that engines running in electric plants were usually anything but economical, 5½ to 10 pounds of coal per hour per I. H. P. being quite common.

Professor Carpenter mentioned one case in which 100 pounds of water was used per hour per I. H. P.

Professor Goss called attention to the fact that the locomotive was giving as good economy as the figures mentioned indicated that electric power plants were giving.

Professor Carpenter, of Cornell University, then presented an elaborate paper describing some tests of an experimental engine of the Corliss type, built by E. P. Allis & Co. This engine has three cylinders, 9, 16 and 24 inches diameter, 36 inches stroke, and can be run simple, compound or triple-expansion, condensing, non-condensing, and with or without jackets. The series of tests have not yet been completed, and no general conclusions can be drawn from them. In fact, they rather tend to show that it is unsafe to draw general conclusions regarding any of the disputed questions of steam engineering; jacketing proved economical or otherwise depending upon pressure used, speed, etc. Decrease of clearance the author thought not in itself detrimental, but that increased radiating and condensing surface accompanying it was detrimental. The best economy obtained was 13.68 pounds of water per I. H. P. for the triple-expansion, and this low economy was accounted for by Mr. Rockwood by the low vacuum—22 to 25 inches.

The next paper was entitled "Tests of a Combined Electric Light and Electric Railway Central Station." By Dugald C. Jackson and Arthur W. Richter. One general conclusion drawn from the paper is that the gains from combining the lighting service with the railway service have, in some cases, been considerably over-rated, and are not at all comparable to the good results from combining two small lighting plants into one, or small railway plants into a larger one.

The last paper was by George M. Brill, entitled "Pipe-Covering Tests." The author gives details of results of tests of a large variety of pipe-covering materials. The tests showed that there are no such great differences in efficiency between the different coverings as is sometimes claimed, and that eight of the best coverings have nearly the same efficiency in the prevention of condensation.

FRIDAY AFTERNOON.

The last afternoon in Detroit was spent in cruising about the Detroit River and visiting various manufacturing establishments.

The first of these was the Public Electric Lighting Plant, where they have five triple-expansion, vertical, marine type engines with cylinders 11¼, 18 and 29 inches diameter, 18 inches stroke, running 200 revolutions, with steam at 160 pounds, each driving four dynamos by ropes, a voltage of 4,800 to 5,200 is used on the arc lighting circuits. Seven Peck boilers are used, equipped with down-draught furnaces. From here the party went to the largest stove works in the world (Michigan Stove Co.), of which W. J. Keep is superintendent, and where his experiments and investigations have been carried on. Here a fine luncheon was served, and the process of stove making on a large scale was witnessed, 1,200 men are employed, and 70 tons of iron melted per day.

The works of the Detroit Oak Belting Company and the city water works were then visited and the boat returned to the city, thus ending a very pleasant and profitable meeting of the society. A meeting which evidently owed much of its success to the cordial hospitality of Detroit citizens and to the efficient labors of the local committee, of which Jesse M. Smith was chairman, aided by men accustomed to managing affairs. The attendance was somewhat smaller than usual and smaller than was expected, being about 200.

A Standard Hose-pipe Coupling Needed.

A correspondent writes us from San Francisco a letter in which he asks:

Is there any standard for hose fittings such as couplings, etc.? If there is will you kindly publish it? If not, why can we not have a standard? There is certainly enough hose in use to make it a necessity. I am prompted to write this owing to the fact that we have considerable trouble furnishing ships lying here for repairs with the necessary reducers, etc., to connect their hose with our hydrants which are all what we call "corporation," from their being the same as used by the fire department of our city.

Any information on this subject will be thankfully received.

We referred this matter to Mr. C. J. H. Woodbury, who in his experience as engineer for the Boston Manufacturers' Mutual Fire Insurance Co., had a good deal to do with tests of fire hose. Mr. Woodbury writes us as follows:

In answer to your inquiry I must say that there is nothing which can be stated as a standard for hose couplings, although there is great need of such a standard.

I think that its importance was first brought before the public in this city at the great fire of November, 1872, at which time cities from many miles around Boston sent their apparatus here to co-operate with the Boston Fire Department, but much of it was entirely useless, because they could not connect their suction hose with the hydrants, nor with the apparatus of the fire department, and after that time a great many of the cities in this vicinity adopted what is known as the Roxbury standard coupling. It consists of a V-thread, 7½ threads to the inch, the outside diameter of the thread on the male coupling 3 1/16 inches.

Mr. Charles A. Lundy, of the Eureka Fire Hose Company, made an extended investigation into the subject about five years ago, in the course of which he learned of four hundred different threads used for hose couplings in the fire departments of the United States.

At the nineteenth annual meeting of the Fire Chiefs Association, held at Springfield, Mass., August 11, 1891, B. J. Sweeney, Chief Engineer of the Chicago Department, read a report of a committee on the subject of the standard hose coupling, in which the following was recommended:

Diameter of Hose.	Threads to Inch.	External Diameter Male Coupling.
2½	7½	3 1/16
2½	8	3 1/16
2¾	8	3⅛
3	8	3⅜
3½	8	4 1/16
4	8	4⅜
4½	8	5¾
5	8	6⅛
6	8	7 1/16

The large sizes refer to the couplings on suction hose. In addition to the screw couplings referred to, there are a number of forms of clutch couplings, some of which give excellent results for durability, tight joints and facility of manipulation.

In many instances the fire departments of adjoining cities are provided with reducers which can be used to join the hose in case that the apparatus of one town is called upon to assist its neighbor.

C. J. H. WOODBURY.

125 Milk St., Boston.

A Comparison Between Engine and Dynamo.

In popular writings nothing is commoner than to find the efficiency of electric machinery and of steam machinery contrasted to the great discredit of the latter. The dynamo, it is said, has an efficiency of 90 to 95 per cent., the steam engine an efficiency of only 10 per cent. What a barbarous machine, after all the labor of a century, the steam engine must be! The comparison is generally made by an electrical engineer, and the first reflection which occurs to one is, that of all people the electrical engineer should be the last to abuse the steam engine; for whatever may be the case in future, at present the dynamo is absolutely dependent on the steam engine. Without the steam engine the dynamo would be a useless mass of wire. But passing over the ingratitude of the electrical engineer, the comparison is unfair, and shows a want of apprehension of that important law of motivity of heat which is one of the two fundamental laws of thermodynamics. Heat energy is undirected, or mob energy. It lies in the nature of the terrestrial conditions in which use has to be made of it, that only a fraction is convertible into directed or mechanical energy. The task of the steam engine is to do its best with the fraction which is convertible, and in that point of view it is not an inefficient machine. The dynamo has a much easier task. Energy is supplied to it in its directed or wholly convertible form, and naturally in transforming one kind of directed energy into another kind of directed energy, only a small fraction need be wasted.—*Prof. W. C. Unwin.*

Absurd Bicycle Practice.

A manifest absurdity is the practice, still apparently universal, of figuring and stating the gearing of the bicycle. It is a survival of the unfittest. When the safety bicycle first came in competition with the ordinary or high wheel, it was quite natural that they should be compared, and it was proper that the crank revolutions of the one should be stated in terms of the other, but now that the ordinary is absolutely dead, why should the old and always inconvenient practice be retained? It would evidently be better all around to give the crank effect of the safety either in the feet of road traversed per crank revolution or in the number of revolutions to the mile. Thus, a 54-inch machine might be called a 14⅛-foot wheel for the number of feet to the revolution, or it might be called a 373 wheel for the number of treads to the mile. Almost any method would be better than the present historical relic.

Literary Notes.

PROBLEMS IN MACHINE DESIGN. By Charles H. Innes, M. A., Engineering Lecturer at the Rutherford College, Newcastle on Tyne.

This is an excellent work for advanced students in engineering and machine design. It contains many practical problems not generally found in other text-books. The first chapter deals in a very concise way with graphic and other methods of finding longitudinal stresses in frame-work structures. This is followed by chapters treating on bending moments; numerical examples on stresses in frame-work structures; tensile, shearing and compressive stresses; cottered joints; connecting rod ends; compression of long rods by longitudinal forces; piston rods; stresses caused by bending, combined with tension or compression; shafting; flange couplings; resilience of shafting, etc.; expansion valve gears; disturbances caused by the moving parts of engines, and the methods of balancing them; governors; springs; capacity of air vessels; fly wheels; diagram factors of compound engines, and method of drawing theoretical diagrams of compound engines.

Rules are given for determining the stresses in various parts of a structure, including some of the principal parts of a machine, and also rules for determining the sizes of some of these parts. In a few chapters tables are inserted which give the dimensions of crank pins, cranks, shafts, etc., at a glance. Designers will find this book to be a valuable one; it is also one of special interest to students. For beginners it is too advanced and concise. The book contains 187 pages 4¾x7⅛ inches. It is published by the Technical Publishing Company, Limited, 6 Victoria Station Approach, Manchester, England. Price, $1.40.

The adoption of a caliber of .236 inch for the new magazine shoulder gun for the navy marks another step toward a smaller caliber for such weapons, and it is thought by some experts that the limit to which calibers can be advantageously reduced for such arms is not much, if at all, above .216 inch. The Lee gun which was adopted is an American invention, and the particular weapon which went through the trials was a wonderfully patched up affair—modified and remodified over and over again, to meet new conditions or overcome new objections. A model gun is being made, and manufacture will soon begin.

NEW CATALOGS.

We have received the catalog of the Union Brass and Metal Mfg. Co., St. Paul, Minn., representing their manufacture of brass goods and plumbers' specialties. The catalog is 11¼"x8¾".

We have received from Thos. Carlin's Sons, Allegheny, Pa., their catalog of contractors' tools and machinery. It is quite an extensive work and embraces a wide range of interesting matter. The catalog is 9"x6¾".

Messrs. Theodore Alteneder & Sons, 939 Ridge avenue, Philadelphia, Pa., send us their catalog of drawing instruments and materials. It will be sent to any address on receipt of four cents in stamps. It is standard size, 6"x9".

We have received from the Betts Machine Co., Wilmington, Del., a folder illustrating and describing their improved horizontal boring and drill machine of the Bement type. The pamphlet is 6⅝"x9½", but could readily be trimmed to standard size, 6"x9".

We have received from A. Aller, 109 Liberty street, New York, a folder illustrating and describing various steam specialties made by him, including steam jet pumps, exhauster and condenser, pressure regulators, feed pumps, chimney draught improvers, water heaters, steam traps, etc.

We have received from the Huyett & Smith Mfg. Co., Detroit, Mich., a finely gotten up catalog, illustrating and describing a large variety of fans and blowers with engines suitable for driving them. These machines are adapted to a large variety of services, many of the applications being illustrated and described in the catalog before us. They are used for dry kilns, for heating and ventilating shops and other buildings. The Smith patent marine water tube boiler is also illustrated and described. The catalog is 6¾"x10¾", and has 138 pages.

MANUFACTURES

A new woolen-mill is to be erected at Oxford, Mass., by N. E. Taft & Son.

The Wagner (Tenn.) Mfg. Co. will shortly erect a cotton-mill to operate by water power.

The Wilkinson Shear Co., of Reading, Pa., was recently organized with a capital of $20,000.

The Slater Woolen Co., of Webster, Mass., will shortly build an extensive addition to its plant.

The Linton Coated-Paper Co., of Richmond, Va., has been organized. E. D. Christian is president.

The O'Connor Furnace and Range Co., of St. Louis, Mo., has been organized with $10,000 capital.

The Shenango Furnace Co., of Greenville, Pa., has been organized with a capital of $300,000. L. L. Keck is interested.

The Racquette Lake (N. Y.) Railroad Company will shortly construct a steam road from Racquette Lake to Axton, N. Y.

The Acadian Lumber Co., of Texarkana, Texas, has been incorporated by Henry P. Rochell with a capital stock of $25,000.

The Sheffield (Ala.) Coal, Iron and Steel Co. has been organized with John Fritz as president. Its capital stock is $1,500,000.

The Atlas Press Brick Works, of Dallas, Texas, has been formed with a capital stock of $25,000 by T. W. Hurst and V. W. Jones.

J. A. Abernethy and J. H. Ramseur, of Lincolnton, N. C., have formed the Lincoln Cotton Mills with a capital stock of $80,000.

The American Register Co., of St. Louis, Mo., has been incorporated with a capital stock of $50,000. J. C. Orrick is interested.

The Moorhouse Mfg. Co., of Savannah, Ga., was recently organized by A. W. Moorhouse and J. J. Higgins with a capital of $25,000.

The Harvey Lee Miller Fertilizer Co., of Callman, Ala., has been organized with a capital stock of $10,000. T. L. Humphrey is interested.

The Baltimore (Md.) High Grade Brick Co. has been incorporated by Chas. F. Diggs and Joseph R Wilson, with a capital stock of $50,000.

The Rush Wheel Co., of Chicago, Ill., has been recently incorporated by Jno. E. Howland and Thomas Koenstein, with a capital of $10,000.

The Jacobson Blosser Electric Mfg. Co. has been recently organized at Portland, Me., with a capital stock of $200,000. C. B. Jackson is president.

The Gaffney Vitrified and Pressed Brick Co., of St. Louis, Mo., has been organized by John Gaffney and G. A. Elbring with a capital stock of $50,000.

The New Orleans (La.) Machine and Shipbuilding Co. has been incorporated to operate machine works and shipbuilding plant with a capital stock of $150,000.

The copartnership under the name of the Evans Friction Cam Company is dissolved. The business will be continued by G. F. Evans in his own name at 85 Water street, Boston.

The Bissell, Dodge & Erner Co., of Toledo, Ohio, was incorporated recently with a capital of $25,000 to manufacture electrical machinery. Among its incorporators are Frederick Bissell and Frederick H. Dodge.

The Lindsay Bicycle Manufacturing Co., of La Fayette, have recently incorporated under the State laws of Indiana for the purpose of engaging in the manufacture of a patent two-speed bicycle. They propose to open up on quite an extensive scale and will produce several thousand wheels per year. They have just placed their order with The Lodge & Davis Machine Tool Co., Cincinnati, Ohio, U. S. A., for the equipment of their entire plant including several screw machines, sprocket milling machines, hub turning machines, cone machines, and, in fact, all tools entering into the manufacture of bicycles.

The Brown Hoisting and Conveying Machine Co. and the Elwell-Parker Electric Company of America, main offices and works at Cleveland, Ohio, have opened a general Western office at No. 1528 Marquette Building, Chicago. Mr. F. G. Tallman, manager of the Pittsburg offices of these companies, and late manager at Pittsburg for the crane department of the Yale & Towne Mfg. Co., will also have charge of the Chicago office, and will be assisted by Mr. Frank B. Ward, late resident engineer of the Pittsburg Testing Laboratory, and for several years head of the firm Frank Ward & Co., inspecting and consulting engineers. The Brown Hoisting and Conveying Machine Co., in connection with their hoisting and conveying machinery and crane business have recently purchased the entire crane business heretofore owned and controlled by the Yale & Towne Mfg. Co. The Elwell-Parker Electric Company of America, which is the American branch of the celebrated English firm of the same name, is making a specialty of heavy electric machinery and large installations.

Machinists' Supplies and Iron.

New York, June 29, 1895.

Iron—American Pig—We quote standard brands, $13 for No. 1; $12 for No. 2; $11.50 to $11.75 for No 2 Plain, and $11.25 to $11.50 for Gray Forge. Southern brands, $12.50 to $12.75 for No. 1; $12 to $12.25 for No. 2; $11.50 to $11.75 for No. 3; $12 to $12.25 for No. 1 soft; $11.75 to $12 for soft; and Foundry No. 4, $11.25 to $11.50.

Antimony—The market is inactive, a moderate business of routine type only has been done. We quote L. X., 8½c. to 8¾c.; Cookson's, 8¼c. to 8½c; Hallett's, 7¾c. to 7.15c.; U. S. French Star, 7½c.; Japanese, 7c to 7⅛c.

Lard Oil—Prime City we quote at 52c. to 53c.

Copper—The market is quiet, and prices are fair and steady. Producers hold out for 10¾c. for Lake Copper, but from second hands it might be bought for 10⅝c. Casting Copper is held at 10½c. to 10¼c.; the demand is improving.

Lead—The market is very quiet; some sales have been made at 3.25c., and 3.27½c. is generally asked.

Spelter—The demand has been satisfactory, but the market is irregular. For New York delivery 3.70c. to 3.75c. is generally quoted.

Tin—The market is quiet without any change of importance. Business has been done at 13.85c. to 14.05c., but the former figure seems to be at present the prevailing one.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS.

On and after July 4th this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Agents traveling and local to sell steam spec's; good commission. Mfr., 1115 State St, Erie, Pa.

Thorough all-round machinist, 20 years experience; engine building; jobbing; desires resp. position. Address Marine, American Machinist.

Wanted—A few first-class machinists familiar with engine work. Address P. O. Box 513, Denver, Colorado.

Wanted—Competent foreman to take charge of wood and metal patternmaking in agricultural works. Address No. 418, care Am. Machinist.

Wanted—Position by draftsman with shop experience. C., care American Machinist.

Wanted—Position by draftsman and designer; experience covers machine tools, electrical apparatus and heavy machinery. M. E., Am. Mach.

Wanted—Position as chief draftsman or special designer by one experienced on both heavy and light work. S. D., American Machinist.

Turret lathe hand experienced on Jones & Lamson 2x24 flat turret lathe, wants position. Box 35, American Machinist.

A mech. engineer with exp. designing and superintending on light machinery and stamping tools wants permanent position. Cycle, Am. Mach.

Draftsman having 14 years shop practice and technical education wishes a situation. Box 36, American Machinist.

Foreman patternmaker, experienced in machine tool gearing, steam engine, special machinery and general jobbing, desires a change. Box 37, Am Mach.

Mechanical draftsman, age 24, desires to change position; experienced in mill building and general machine work, also familiar with steam engine indicator; good refs. Draftsman, Am. Machinist.

Wanted—Place as foreman or supt., by practica, man of large experience who believes in jigs and special tools for quick accurate work. Address A. D., American Machinist.

Wanted—Position as foreman or to lay out in boiler or gas holder works; 10 years' experience as foreman; A1 references. Address Box 34, American Machinist.

Wanted—A competent manager for boiler works and machine shop; must be experienced and able to give estimates if required. Address F. C., 59 Liberty St., Room 16, N. Y. City.

Wanted—By a competent mechanic of large experience and who understands modern methods; position as supt., foreman or master mechanic of machine shop; best of references. E., Am. Mach.

Machinist's apprentices; strong, active boys wanted; must be 16 years old; trade thoroughly taught in all its branches; instruction in mathematics and mechanical drawing gratis; wages first year $2 per week. Apply by letter only. R. Hoe & Co., 504 Grand street.

Foreman wanted for a machine shop not far from Chicago. About 150 men employed on medium heavy work. Modern equipment and methods. Good salary and permanent position for a thoroughly competent man. Address Box 21, American Machinist.

Wanted—An energetic foreman of a bridge mfg. company's machine shop. Should be familiar with bridge work, machinery of plant, and capable of general repairs. State age, experience and salary expected. Plant is a large one, and good salary paid to competent man. X. Y., Am. Machinist.

Wanted—Traveler or foreman machine shop (not an ornamental M. E.) to take an interest in an established machine tool concern in excellent shape; must have not less than $5,000, which may be placed for a while as a loan upon security with privilege of investment later; location Philadelphia. Address Penn, care American Machinist.

Wanted—Assistant foundry foreman in a New England city; must be accustomed to light and heavy machinery and steam engine work, acquainted with the latest and best foundry methods, and have first-class executive ability and push; state nationality, age, and give full account of experience; give references and state salary expected. Address New England Foundry, care American Machinist.

A general manager wanted for a steam engine and dynamo-electric manufacturing establishment; must have experience, energy and executive ability, and be able to put some capital into the business; a modern plant, located near New York, costing over $200,000; a "going concern," with abundance of profitable orders already secured, offers unusual inducements for capital and experience. Address, giving experience and references, F. J. K., Post Office Drawer 171, Buffalo, N. Y.

MISCELLANEOUS WANTS

Advertisements will be inserted under this head at 25 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

For Sale—Second hand planer, also lathes. Gage Machine Works, Waterford, N. Y.

Machine shop wanted; will take interest if desir'e; can furnish abund'e of work. Box 12, Am. Mach.

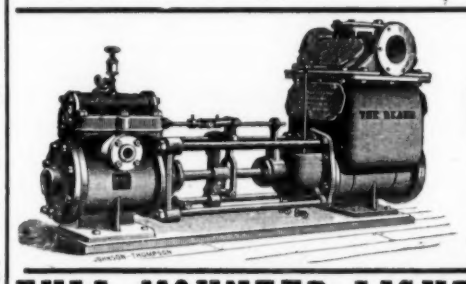
If H. G. Hubbard will communicate with his father will hear something to his advantage.

For Sale—13 vols. of A. M. bound; cheap. S. Heberling, Des Moines, Iowa.

Wanted—To correspond with any one in need of a first-class key-seater. Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

For Sale—A foundry and machine shop with tools, in the thriving town of E. Stroudsburg, Pa.; water power; terms easy. Address Box 516 for further particulars.

Introduction and negotiation of Americanpatents and machinery to English manufacturers and agents. Write for circular to Geo. Richards, M. I. M. E., Mechanical and Consulting Engineer, No. 5 Laurence Pountney Hill, London, England.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A STOCK WITH EACH DIE.
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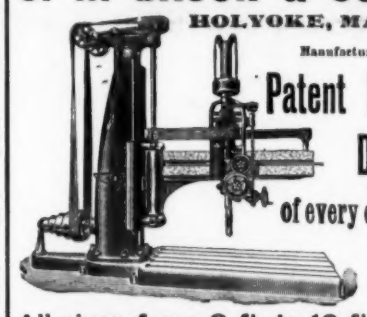
Patent Radial Drills of every description.
All sizes from 3 ft. to 10 ft. arm.

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12mo, Cloth, - $2.50.
JOHN WILEY & SONS,
NEW YORK.

WRIGLEY'S EMERY WHEEL DRESSER
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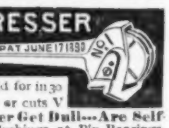
To be returned or paid for in 30 days. It faces rapidly or cuts V grooves and all Shapes. Cutters Never Get Dull—Are Self Hardening. Has Hardened Steel Bushings at Pin Bearings. Price, $2.00; Cutters, 15 cts. per set. Send for Circular.
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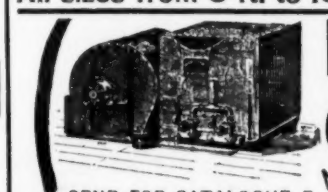
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SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS. No WASTE in redressing.
SOLE REPRESENTATIVES IN THE UNITED STATES.
B. M. JONES & CO.,
BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.

ARE YOU LOOKING
for a lathe? We are building them in various sizes from 9" to 24" swing, in various lengths, both engine and speed lathes. Our designs are the **latest**, while the **workmanship, material** and **finish** are of the **highest** order. Our catalogue will tell you all about them, as well as of our planers, shapers and other tools. A postal will bring it.
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117 and 119 Culvert St., CINCINNATI, OHIO, U. S. A.

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FOR LAGGING LOCOMOTIVE BOILERS.
Samples and Descriptive Price List Free by Mail.
We are prepared to take Contracts for applying Steam Pipe and Boiler Coverings in any part of the United States.
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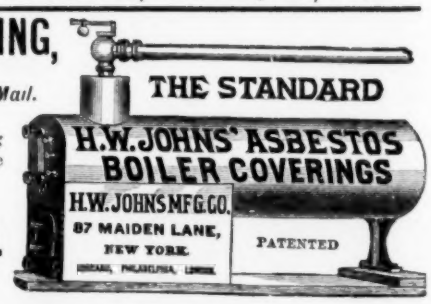

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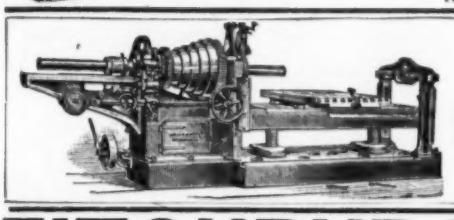

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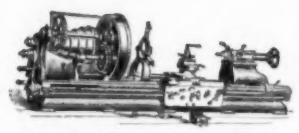

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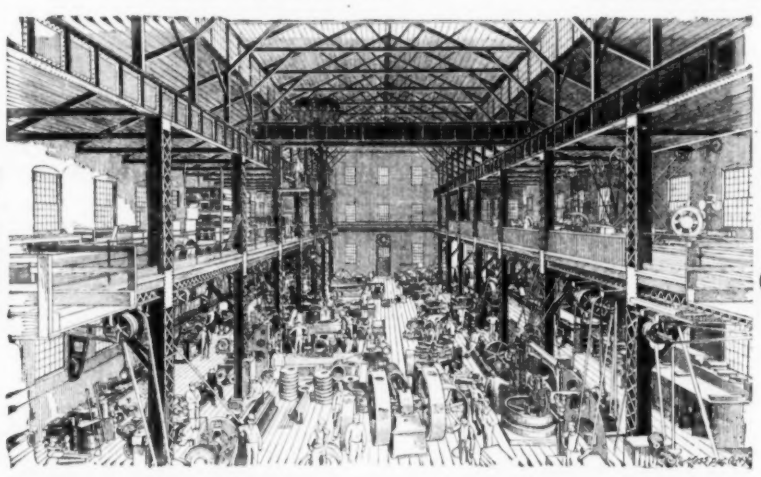

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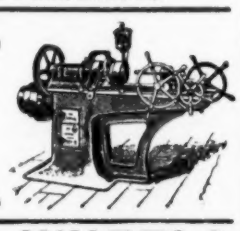

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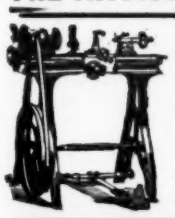

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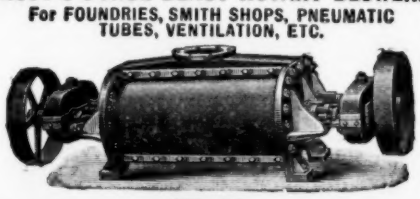

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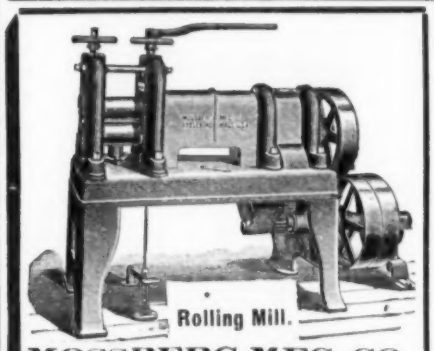

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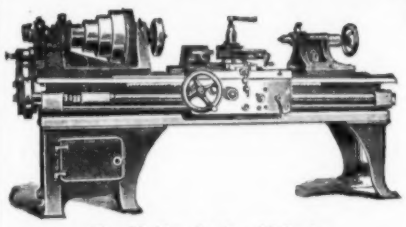

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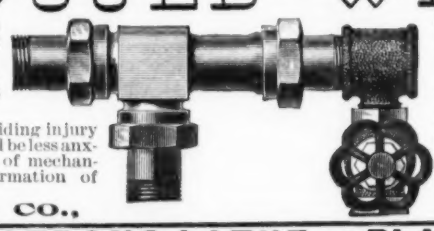

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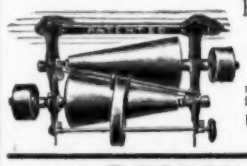

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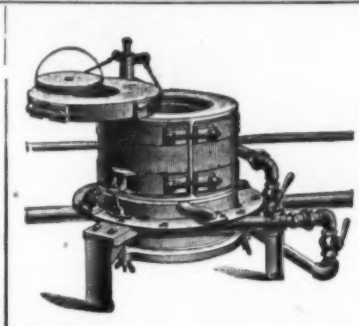

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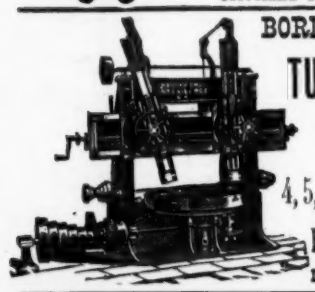

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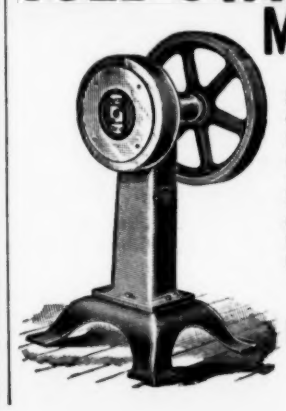

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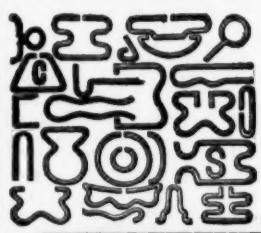

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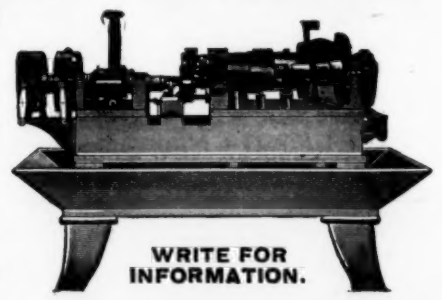

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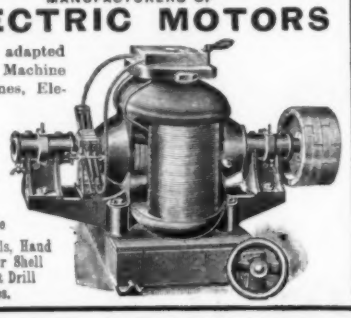

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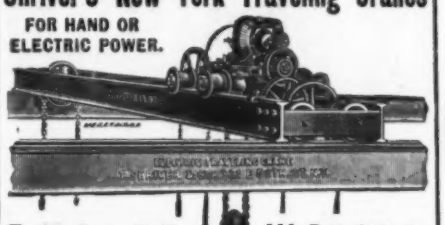

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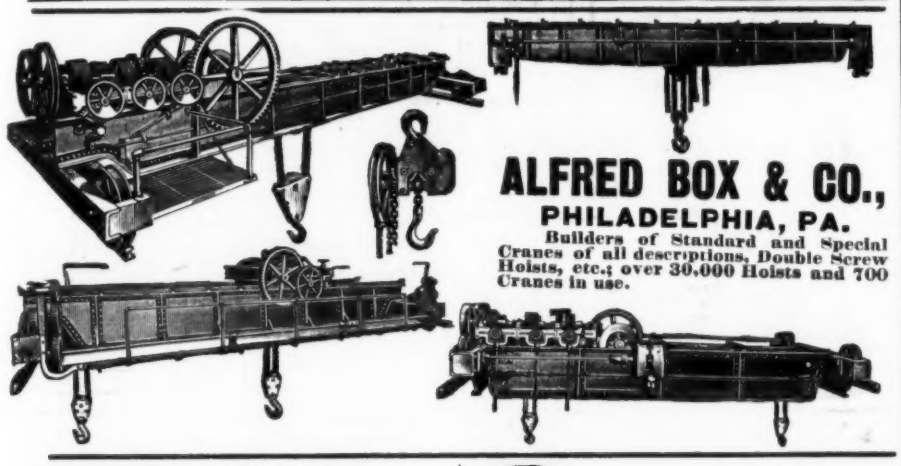

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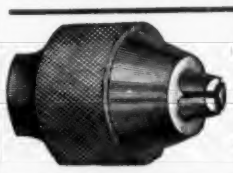

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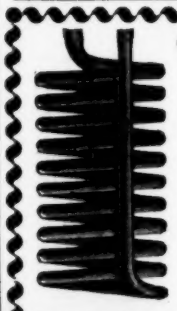

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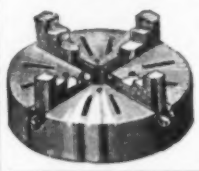

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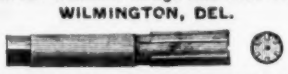

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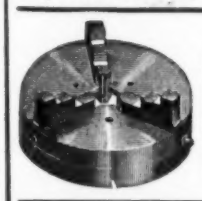

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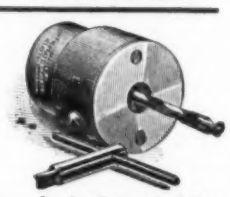

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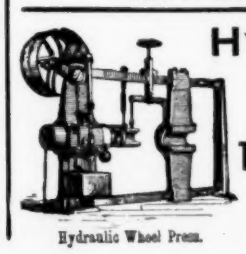

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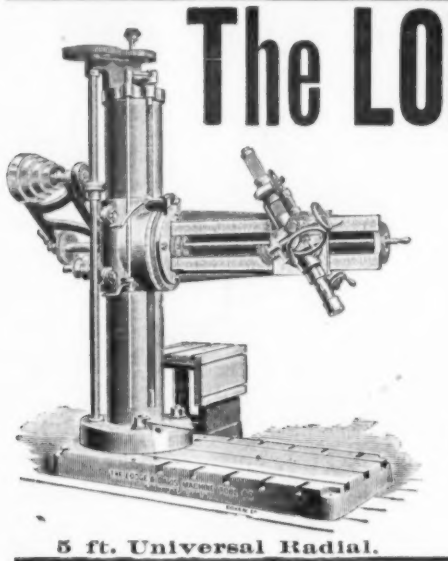

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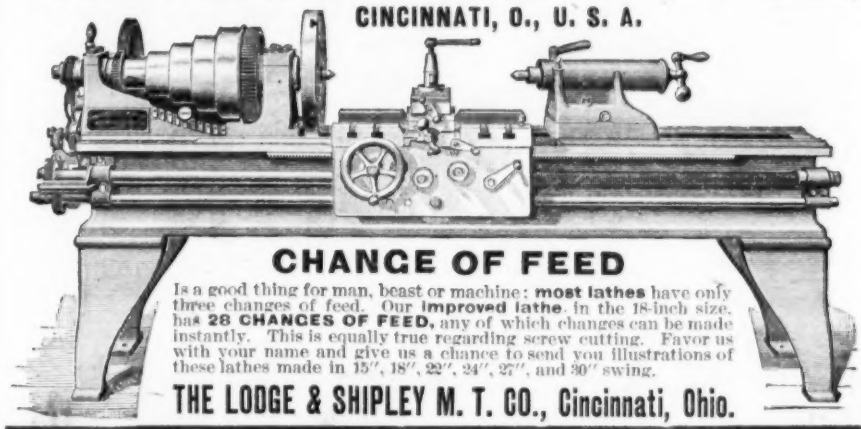

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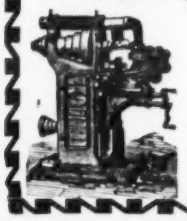

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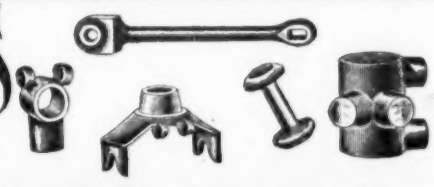

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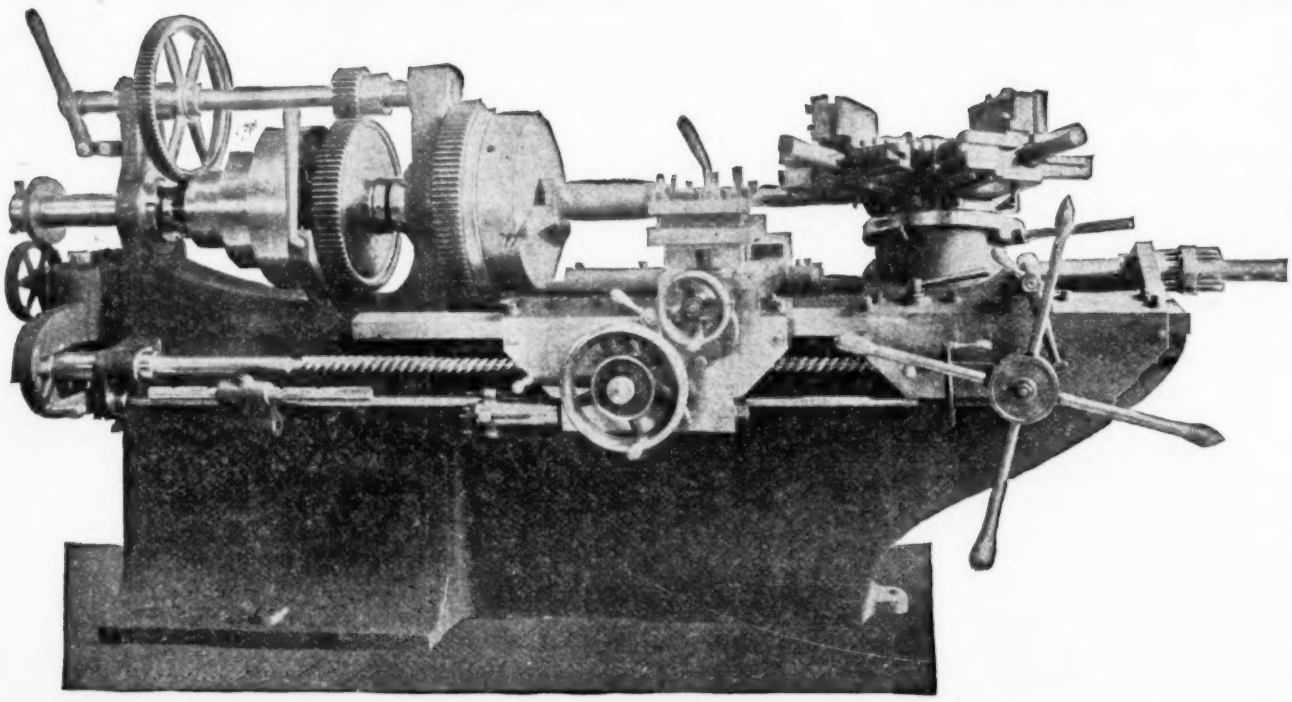

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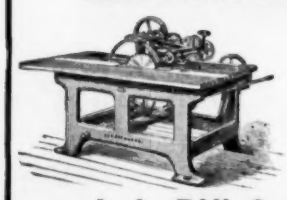

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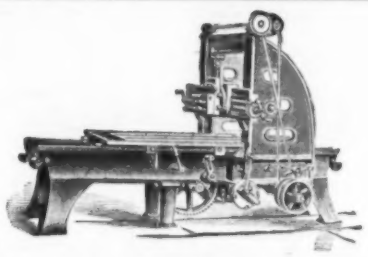

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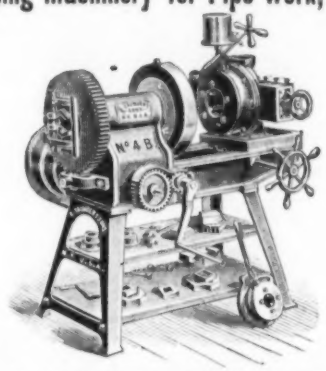

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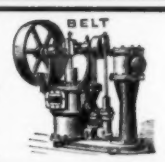

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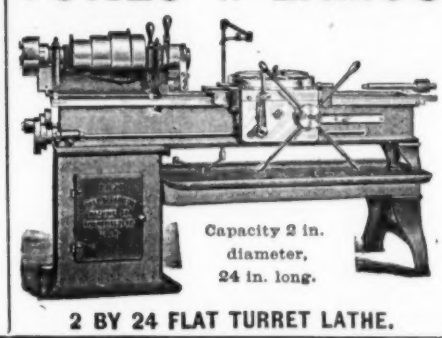

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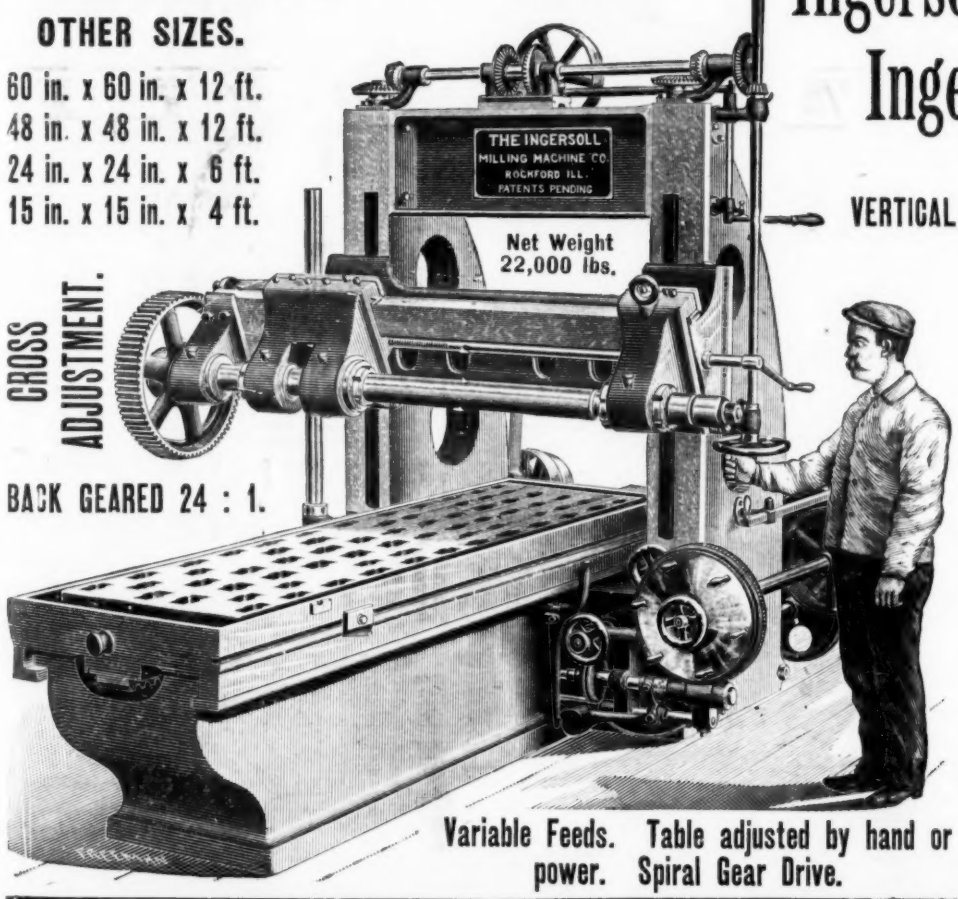

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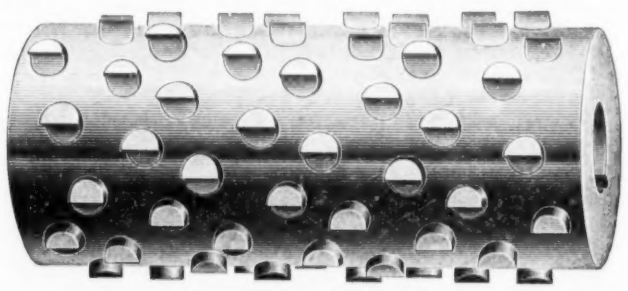

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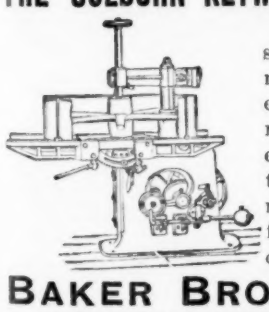

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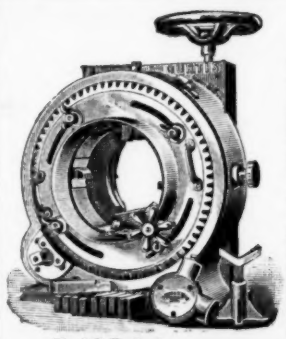

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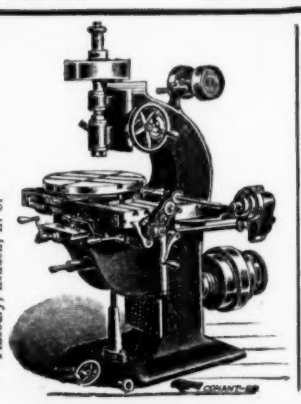

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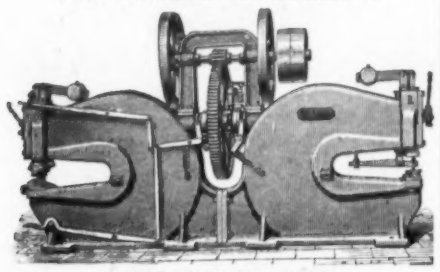

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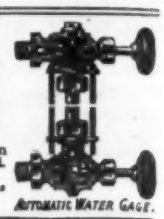

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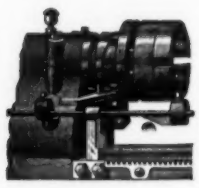

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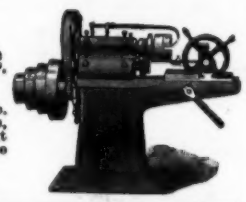

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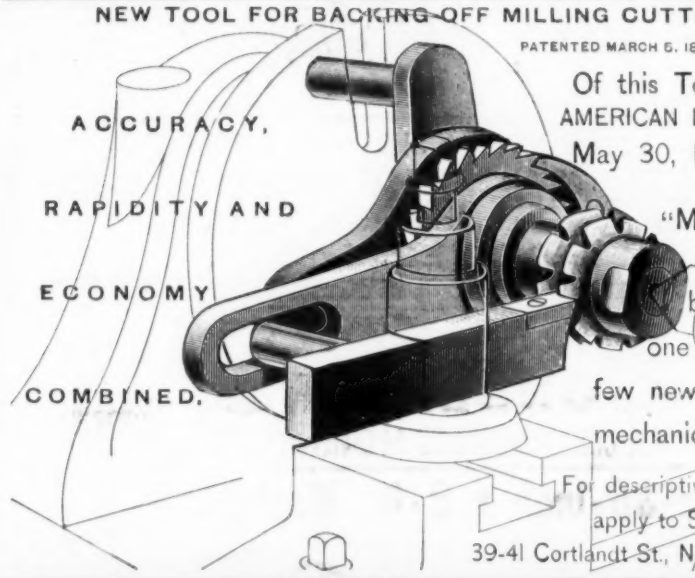

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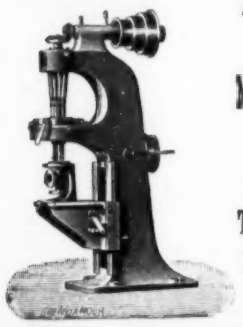

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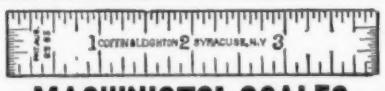

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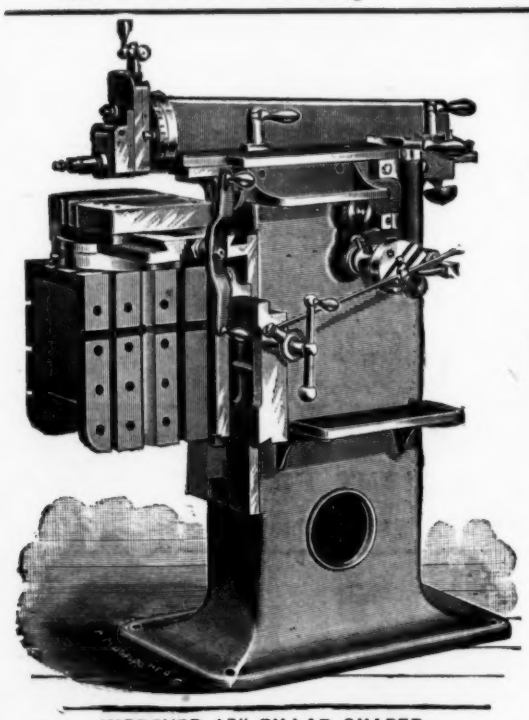

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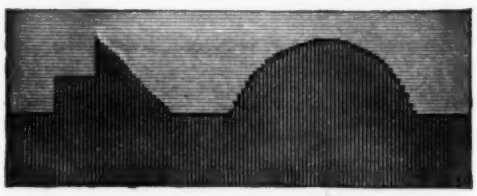

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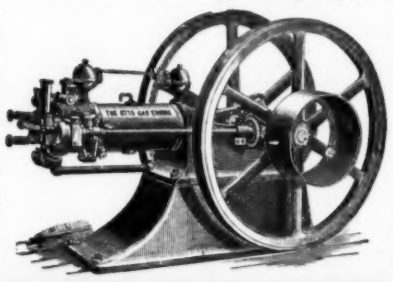

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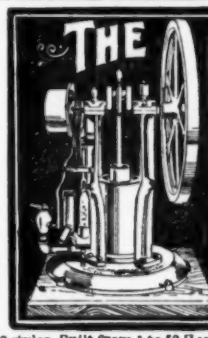

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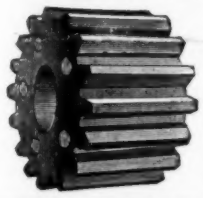

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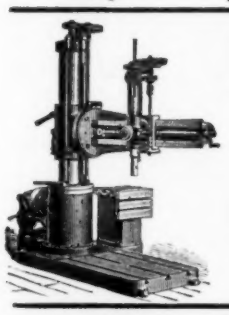

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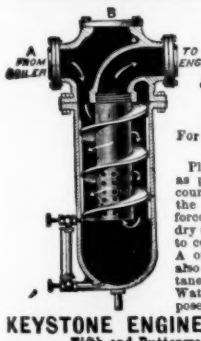

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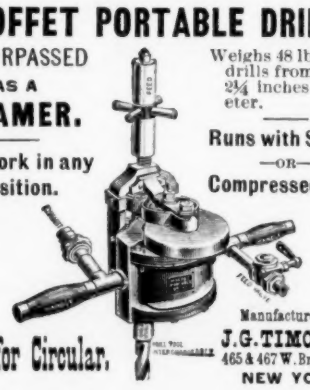

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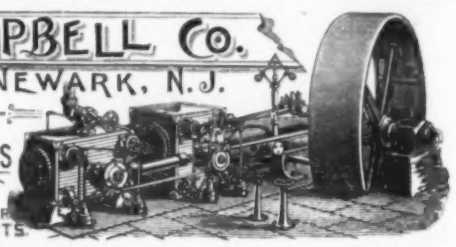

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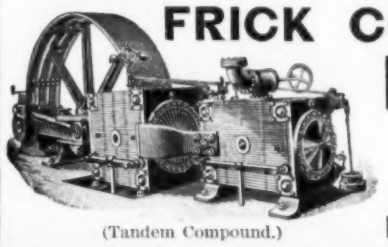

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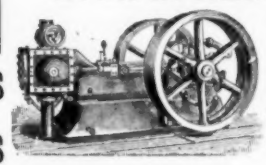

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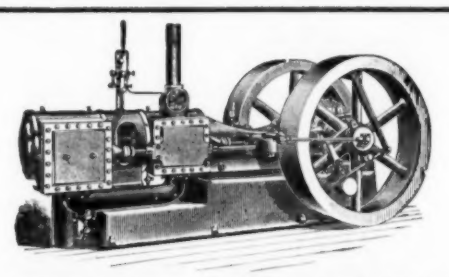

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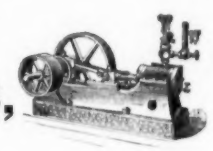

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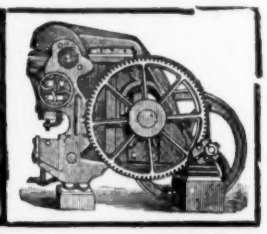

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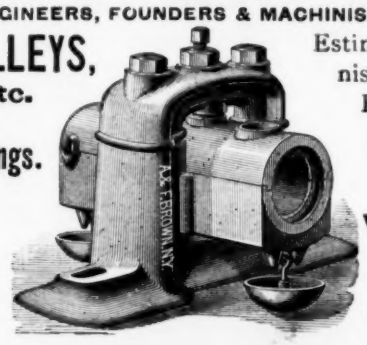

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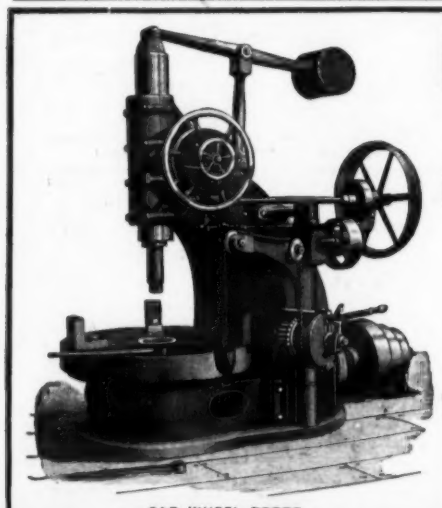

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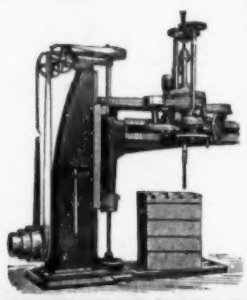

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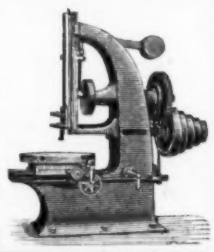

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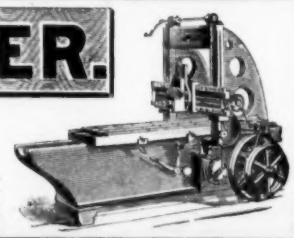

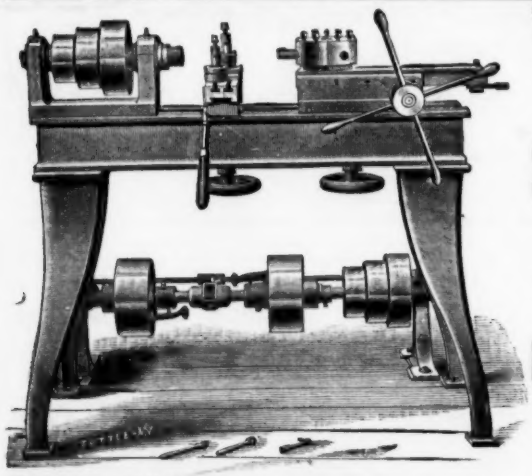

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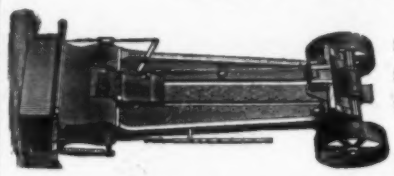

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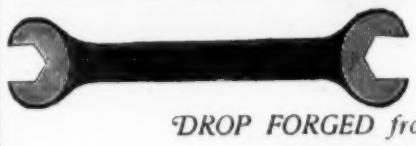

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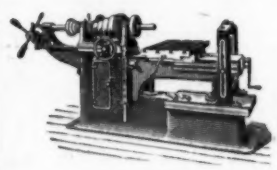

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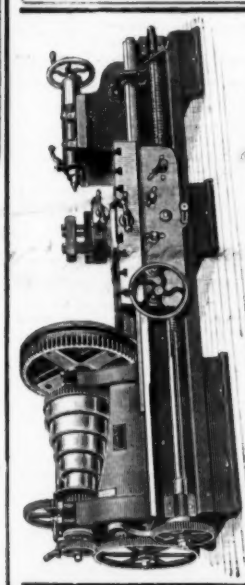

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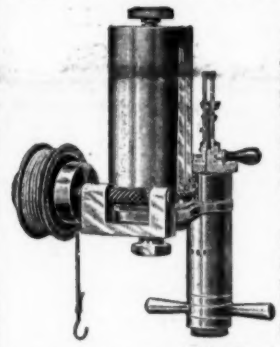

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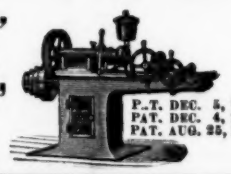

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